

ANNALS of SURGERY

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THROMBOPHLEBITIS OF THE LOWER EXTREMITIES*

By JOHN HOMANS, M.D.

OF BOSTON, MASS.

ONE can hardly see many patients suffering from ulcers of the leg without being struck by the number of those who present areas of œdema, induration, discoloration and ulceration for which varicose veins of the familiar type are clearly not responsible. Such areas are often extensive, unassociated with trauma and seem to have no adequate cause. They are the source of much pain and disability, particularly in the working classes.

In questioning a considerable group of such patients it will be found that nearly all have suffered at some time from a recognized thrombophlebitis, that is, a "milk leg," or a similar disease occurring in the course of convalescence from an operation or an acute fever such as typhoid or pneumonia. In some instances the connection between the late complication and the thrombosis is very direct and obvious, in others remote and obscure. As a rule, venous stasis, as exhibited by dilated veins or blueness of the extremity, is little marked or altogether absent. On the other hand, the condition which one is accustomed to associate with acute or chronic lymph stasis, that is, porky œdema of the tissues, is almost invariably present. The cause of these late results is perhaps to be found in the nature of the original thrombosis.

The venous thromboses, as one familiarly sees them, appear to be divisible into several categories. The *first*, which has long been known as phlegmasia alba dolens, apparently represents a thrombosis of the principal deep veins of the limb, a thrombosis which may perhaps begin in the pelvis, iliac thrombosis, but which gives the impression in some instances of a considerable involvement of the femoral vein as well. Fever is usually present. The swelling is evenly distributed and may be very tense. The *second*, which may perhaps occur as a complication of the first but which as a rule is an altogether independent process, takes the form of a thrombosis of superficial veins external to the muscular aponeurosis, a disease which is marked by the presence of palpable thrombus formation in the great saphenous system of veins, and, as a rule, by evidence of inflammation about these vessels. Both these types, particularly the second, may be followed, after recovery from the original attack, by a secondary development of œdema, induration and ulceration. The *third*, represents thrombosis in varicose veins. This disease is very common, tends to be recurrent, and causes, compared with the first two, little disturbance outside the immediate vicinity of the thrombosed vessels. There is often

* Read before the American Surgical Association, May 14, 1927.

swelling and redness over the inflamed varicose veins, but the intensity of the process varies widely between individual cases.

Inasmuch as the immediate and remote effects of thrombophlebitis in veins already varicose differ decidedly from the results of thrombosis of the first two classes, that is, where the veins have hitherto been normal, it will be convenient to discuss this disease now and to dismiss it from further consideration.

Thrombophlebitis in Varicose Veins.—The changes in the vein walls incident to varicosity are primarily responsible for the thrombosis. Trauma and infection are probably exciting causes. More or less of the great saphenous system may be affected, but thrombosis usually begins in the calf or lower thigh and progresses upward. The process, if it reaches the saphenous opening, appears to stop there, for there is rarely any evidence of a disturbance of the deep venous circulation. The course of the disease, though slow, is favorable. Suppuration is rare; the veins are ultimately canalized, never permanently destroyed or obstructed.

Since recovery from the thrombosis brings no relief from the basic varicosity, since the condition itself is disabling and since embolism occasionally occurs, removal of the thrombosed varicose veins, if safe, is clearly indicated. That it is safe and has proved a highly satisfactory procedure is demonstrated by the results of a considerable number of such operations performed at the Peter Bent Brigham Hospital, Boston, during the last fourteen years. It has been the custom to operate as soon as the local inflammatory reaction, if severe, has so far subsided that the infection seems unlikely to be spread by removal of the thrombosed vessels. If necessary, adherent skin is excised with the veins. The operation is begun in the groin at the saphenous opening to obviate the danger of embolism. The immediate and late results have been excellent and though the total number of cases has been too few to enable one to state that the operation may not be a source of embolism, no such accident has occurred. Moreover, the evidence offered by the following case goes to show that the detachment of clots may be a real danger in patients not subjected to operation and is likely to be obviated by removal of the veins:

A young woman suffering from thrombosed varicose veins came to the hospital four months pregnant. She had recently spat up blood on several occasions. X-rays of the chest suggested the possibility of tuberculosis. The thrombosed veins were removed under local anæsthesia without disturbing the pregnancy. Following the operation hæmoptysis ceased, and reëxamination of the chest suggested to the radiologist the presence of healing multiple infarcts.

In thrombosis of veins already varicose there is, as compared with other forms of thrombosis, a remarkable absence of secondary disturbances in the forms of œdema, induration or ulceration of the calf. Apparently, therefore, an antecedent varix offers a certain protection against lymph stasis. Indeed, it may be true that the lymph channels which normally accompany the superficial veins are gradually destroyed early in the course of varix, that new lymph channels become established and that these are not disabled when

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thrombosis of the varicose veins occurs, being out of reach of the inflammatory process. This is getting rather ahead of the story of lymphatic obstruction which will come up insistently in the discussion of thrombophlebitis in normal veins.

Thrombophlebitis of the Deep Veins of the Legs.—No attempt will be made here to account for the incidence of this disease. Nevertheless, the general swelling of the leg and thigh, even the buttock in some instances, points to a circulatory obstruction within the pelvis, and since a thrombophlebitis during the puerperium (which would be likely to have a uterine origin) cannot be distinguished from any other form of deep thrombophlebitis, it seems probable that phlegmasia alba dolens always arises in the pelvis, involving primarily perhaps, the internal, and secondarily, the common iliac vein. How far peripherally the process extends is very difficult to say. Supposedly collateral vessels may appear upon the upper thigh and even upon the abdominal wall, showing that the upper femoral vein has been at least temporarily obstructed, and I have recently studied a patient in whom, after the swelling in the early course of the disease has subsided, a collateral venous anastomosis about the knee was in evidence, as if the popliteal veins were still plugged. Such a state is perhaps unusual. More often no evidence of venous congestion in the lower leg is present. It is tempting, therefore, to suppose that there are very local thromboses causing a brief and slight disability and extensive thromboses causing a long-lasting disability.

As is well known, a phlegmasia alba dolens is usually ushered in by fever and by pain in the calf, the popliteal space or perhaps the groin. Almost at once the lower leg begins to swell but does not turn blue. Why the absence of blueness? Is it actually present but engulfed in the œdema, or is a collateral venous circulation so readily established that venous congestion of the limb is never a serious feature of the disease? I lean to the latter view. My one experience of dividing a normal femoral vein in the groin showed that the resulting blueness of the leg died out within forty-eight hours, after which neither venous obstruction nor any swelling of the limb was ever noticeable. Moreover, in dogs, division of the femoral vein causes no visible circulatory changes of any sort. It would then seem highly probable that a venous thrombosis, spreading peripherally, leads to so rapid a development of a collateral circulation that blood has no particular difficulty in leaving the leg. Even if such were not the fact, venous obstruction alone would fail altogether to explain the white swelling of a deep thrombosis.

In the course of a day or two following the onset of the disease, swelling is at its height. As a rule the leg and thigh are evenly enlarged. In mild cases the condition persists for a week perhaps, then gradually subsides, so that within two or three weeks from the time of onset the leg has returned to a normal size. Thereafter, some œdema returns as the patient begins to get about, but is never again serious. In a more severe form of the disease, fever and swelling persist with little change for as long as several months. Even then a complete recovery may follow, but, as I shall presently show, after a

prolonged illness of this sort, a disabling complication is likely sooner or later to set in.

The complication to which I have alluded takes the form of a porky œdema in the superficial tissues of the calf, usually on the inner and anterior face but not rarely upon the posterior surface, or low down, upon either side of the ankle. As a rule there is one large area of this sort. (Figs. 1 and



FIG. 1.—M. S. No. 11973, O. D. D. A mild and late œdema and induration with healed ulcer, following a "milk leg," left, six years earlier—presumably iliac and femoral thrombophlebitis. At that time, swelling lasted three to four months. Subsequently, aching discomfort in calf. For two months, noticeable hard lump on inner, lower calf. Ulcer formed and healed under bandaging. Area of induration extends to the back of the calf. Disease stationary under elastic stocking.

2.) Occasionally, scattered lesions, altogether separate from each other, appear. Rarely a broad ring is formed about the leg. This œdema sooner or later becomes indurated, the skin over it pigmented, and if the patient must spend much time in standing, the indurated area finally breaks down wholly or in part and becomes an obstinate ulcer. I previously supposed that such changes appeared only after a superficial thrombophlebitis, that is, of the great saphenous vein. It is true that they are more likely to follow a superficial than a deep thrombosis, but they certainly occur in the absence of any disease of the superficial veins. For want of a better term, I have come to describe these superficial areas as postphlebotic indurations.

If the tissues are incised they give the impression of a rather chronic nonsuppurative infection. The fat is scarred and œdematous, and as the muscular aponeurosis is approached the scar tissue becomes denser. In extreme instances it has something of the appearance of true elephantiasis. Indeed the deep fascia covering the muscle may be one-quarter inch in thickness, remarkably dense and tough. Beneath this level the process no longer appears. The inner surface of the aponeurosis and the delicate reticular tissues beneath it are undisturbed. Such a condition as this may develop a number of years after the original thrombosis or it may appear within a few months. It progresses slowly and steadily or in waves and may lead to a state in which amputation is considered.

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What then is the explanation of the white swelling associated with a deep thrombophlebitis, with its variations in intensity, its tendency to slow recovery and its occasional sequelæ? It is difficult to escape the conclusion that a disturbance of the lymphatics is at the bottom of the process. One must suppose that the inflammatory process associated with thrombosis promptly involves the principal lymphatic trunks draining the limb. There is no reason

why it should not do so, since these trunks hug the veins very closely and may even be embedded in the adventitia of their walls. Moreover, the great vessels at the root of the leg and the iliacs as well are closely bound together in a tough fibrous sheath. Sabin¹ has described the origin of the lymph vessels of the legs. They arise in the embryo from primary iliac sacs dorsolateral to the aorta. A common iliac branch divides into two main trunks, an internal and external iliac, or femoral. The latter drains the two sets of lymphatics from the lower limb, the superficial and deep. Reichert² states that in animals "most of the superficial lymphatics of the leg and foot, as well as some of the deep lymphatics that drain the muscles of the leg, terminate in the popliteal lymph

gland. From this gland large efferent trunks course along the femoral vessels to end in the external iliac glands just distal to the bifurcation of the aorta. Many of the superficial lymphatics of the thigh and upper leg drain into the inguinal lymph glands, which in turn have efferent vessels terminating in the external iliac glands. The deeper set of lymphatics in the muscle sheaths of the thigh eventually enter trunks that accompany the main femoral lymphatics and drain into the large iliac glands." Thus it is inevitable that a lesion completely blocking the main lymph vessels at the groin or central to this point will cause lymph stasis of the entire limb, and it is highly probable that the intensity and the duration of lymph stasis in any instance of thrombophlebitis is dependent upon the violence of the inflammatory reaction associated



FIG. 2.—A. D. No. 78,566, O. D. D. Moderately severe oedema and induration of both legs following bilateral "milk leg," most marked on the right, ten years earlier—presumably an iliac and femoral thrombophlebitis. Was laid up for nine weeks, then swelling slowly disappeared. For the last five years pain in calves with oedema. For two years ulcer on and off in right leg. The disease is progressing.

with the thrombosis, with the length of the thrombosed area and with the haphazard local anatomic variation which the lymphatics seem to possess.

Experiments of Reichert, based on earlier suggestive work of the late Professor Halsted, in which the latter attempted to produce elephantiasis chirurgica in dogs by replantation of the hind leg, throw light upon the relation of venous and lymphatic obstruction to swelling of a limb. Reichert made a complete circular incision of the thigh down to the bone, sparing only the femoral artery and vein but dividing their adventitia; then reunited the cut surfaces with great care. In all experiments the limb swelled but showed no sign of gangrene. Swelling began on the second day, reached its height on the fourth or fifth day and had completely subsided by the seventh or eighth day. Injection experiments showed a regeneration of lymphatics beginning on the fourth day. He found that if, on about the eighth day, when the swelling had just subsided, the femoral vein were ligated, no recurrence of œdema appeared nor any untoward symptoms. If ligated while the swelling was at its height, subsidence of œdema was only slightly delayed. If, on the other hand, the lymphatics were blocked with India ink at the time the swelling had just subsided, œdema reappeared. Thus the importance of divided lymphatics as a cause of this swelling was demonstrated. Incidentally Reichert found, as others had before him, that infection and scar-tissue formation decidedly retarded the reestablishment of lymph channels. Apparently, however, no instances of elephantiasis developed among his experimental animals.

Very recently, I have attempted to reproduce in dogs phlegmasia alba dolens. In one animal, under full anæsthesia, the femoral sheath was incised longitudinally just at the inguinal ligament. The vein was carefully isolated and ligated. About two inches below this point the femoral vein was again exposed and elevated upon a fine silk ligature. Two cubic centimetres of muscle juice taken up in saline solution was then injected into the segment of vein so isolated and the intima of the vein scratched with the needle. The lower ligature was then tied, and to be certain that no circulation could pass through the segment, several entering veins were divided as well.

Within forty-eight hours a typical "milk leg" developed, though the animal did not seem distressed and never exhibited any evidence of pain. At the end of four days the œdema was at its height and involved the paw. Thereafter it gradually subsided, though at the end of seven days it was still present, particularly in the thigh. At the end of ten days swelling had disappeared and the animal was killed by chloroform. The vein was found thick-walled and very adherent to the tissues about it. Only a fragment of clot, showing evidence of slight cicatrization, remained. In another animal the common iliac vein was divided in a similar way through an abdominal incision and an even longer segment was isolated by a second division below the inguinal ligament. No entering branches were ligated. Only a slight œdema of the thigh, which reached its height on the second or third day after the operation, developed. The explanation of the failure to obtain a typical œdema in

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this instance was found when the animal was killed by chloroform on the eighth day. There was, as compared with the first animal, little or no reaction about the vein. Moreover, no clot could have formed within the supposedly isolated segment, since blood evidently entered it by way of the deep epigastric vein and escaped by way of the internal iliac vein. However, this experiment serves as a good control for the first, that is, it demonstrates the failure of mere *division* of the common iliac and femoral veins to cause any material disturbance of the venous or lymphatic circulation.

In a third dog an attempt was made to interrupt the lymphatics without injury to the vein. Here the sheath surrounding the femoral artery and vein, together with the loose tissue about it, was excised for a distance of about one inch, though the adventitia of the vessels was not completely removed. Then a fragment of gauze was twined loosely about the vessels. Œdema of the thigh down to, but not below, the knee followed. It reached its height on the second and third day; then disappeared. Evidently the interruption of the perivascular lymphatics was not extensive enough to cause any important lymph stasis.

Admittedly, these experiments, though suggestive, are incomplete and require repetition and expansion; but even from the evidence presented here, it appears that phlegmasia alba dolens represents a lymphatic obstruction of uncertain intensity due to inclusion of the trunk lymphatics of the leg in the thrombophlebitic process and that simple division of a vein has no power to cause this obstruction. It remains to explain the reestablishment of the venous circulation and the secondary complications.

It is almost certain that the venous return is cared for, so far as the iliac veins are concerned, by absorption or canalization of the thrombus. In the interval, collateral vessels carry on the venous circulation. For such veins as the iliacs, which have no valves, this means restoration to a nearly normal state. On the other hand, the femoral vein, which depends upon valves for its efficiency, must in all probability be disabled by thrombosis and canalization. If this is the case, why does there not follow a high degree of venous stasis? The explanation probably lies in the remarkably abundant and ingeniously arranged anastomotic channels known to be present among the deep veins of the thigh and leg. Otherwise cyanotic legs would be the rule after a deep phlebitis, which they are not.

The areas of superficial œdema and induration which have already been described as occasional late complications of iliac and femoral thrombosis are explainable upon much the same grounds as true filarial elephantiasis.†

† I was not familiar, when this paper was written, with Matas's clear and convincing description of elephantiasis, especially in its relation to phlebitis, lymphangitis and lymphadenitis, published in 1913. Matas makes no effort to explain the relation of phlebitis to lymph stasis, but discusses the effect of repeated cutaneous infections upon lymphatic obstruction and the permanent states of elephantiasis which he treated with success by the method of Kondoleon. The conditions described by Matas are, of course, more advanced and extensive than those described and figured in this paper but the principle is undoubtedly the same.

They never seem to follow mild instances of phlegmasia alba dolens, but rather those processes which are so obstinate and prolonged as to lead to scar-tissue formation outside of the deep fascia. Although both deep and superficial lymphatics are in the beginning obstructed, there is no evidence that permanent disability is suffered except by the superficial vessels. Bardeleben illustrates the course of the deeper layer of superficial lymphatics in the calf (Figs. 3 and 4), and his description agrees, in the main with that of Reichert. I should judge that it was the destruction of these lymph vessels in particular which causes the characteristic scar formation immediately superficial to the muscular aponeurosis in the calf. Scar formation and lymph stasis tend to form a vicious circle, resistance to infection is low, trauma is common and thus ulceration is in the end almost inevitable.



FIG. 3.—The course of the deep layer of superficial lymphatics. These vessels, which at first follow closely the larger trunks of the great and lesser saphenous veins, join the deep lymphatics and follow the femoral vein upward. (After Bardeleben.)

Superficial Thrombophlebitis.—Superficial thrombophlebitis, that is, of the great or lesser saphenous systems, causes a more direct and general disability of the surface lymphatics than thrombosis of the deeper veins. Whereas an iliac thrombosis, rapidly resorbed, may cause a widespread but brief swelling of the limb and only indirectly disable the superficial lymph vessels, a saphenous thrombophlebitis is likely to obstruct many superficial lymph channels directly and simultaneously. These channels follow the course of the superficial veins. (See Fig. 3.) That they are gradually disabled and take new courses as varix gradually develops has been offered already as a reason why thrombosis in varicose veins causes so little swelling and induration of the subcutaneous tissues as compared with a no more extensive thrombosis in veins not already varicose.

A very striking demonstration of the effect of a thrombosis in a superficial vein previously normal is offered by the following case:

S. L. Y., entered the Peter Bent Brigham Hospital suffering from pain, redness and swelling along the course of the great saphenous vein and some of its branches in the calf. In the course of several weeks the disease subsided and he left the hospital with some oedema of the calf. A few weeks later he suffered a repetition of the attack, but did not return to the hospital until six months later when the whole front and inner side of the calf were found to be reddened and indurated, with a zone of oedema surrounding the area of most intense inflammation. A week in bed left the local process

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less inflamed but well defined and the hardened veins could be felt in the thigh and leading into the diseased area. Ulceration had not occurred. The saphenous vein was removed from the groin down to, and as far as possible through, the indurated region, and by long, straight incisions two broad strips of thickened deep fascia were excised through the midst of the area and for some distance above and below. Healing was satisfactory, and now, six months later, the leg is vastly improved. Whereas formerly the patient had to spend most of his day with his leg elevated, he is now able to work. However, superficial lymph stasis is not altogether abolished. The operation should, I believe, have been more radical, *i.e.*, more of the deep fascia should have been removed.

This case is fairly illustrative of the late result of a superficial thrombophlebitis. Not all patients develop secondary troubles so rapidly, nor is it possible to say what proportion suffer late complications. If, however, the original attack is severe, and particularly if it is repeated, lymphatic obstruction and its consequences are almost inevitable. It appears also that an attack of superficial thrombosis permanently disables the great saphenous vein and many of its branches, so that the veins, though small and fibrous, are valveless. Moreover, the perforating veins, which should aid the superficial system by carrying blood from it into the deep vessels, are usually rendered incompetent. Thus the surface veins tend to be even more congested with blood than is the case in the ordinary type of varix, and congestion may be so marked as to give the impression that the deep veins are varicose. Such is not the case. I doubt if they ever become varicose, but after a widespread persistent superficial thrombosis, where there is added to the cedema and induration of lymph stasis the congestion due to superficial varicosity and disabled perforating veins, the state of the lower leg is bad and gives the impression that the venous circulation is severely damaged.

Treatment.—The treatment of thrombophlebitis in hitherto normal veins naturally divides itself into the management of the thrombophlebitis and of the postphlebitic cedemas and indurations. In respect to the immediate treatment, I doubt whether anything operative can or should be done for an iliac phlebitis unless the patient is clearly suffering from repeated pulmonary infarction and septicæmia. Then the attempt should be made, perhaps, to tie off the common iliac vein or even the vena cava central to the process. In the case of a superficial phlebitis the case is different. Ligation of the great



FIG. 4.—The course of the deep lymphatic trunks along the femoral vessels in Hunter's canal. (After Bardeleben.)

saphenous vein above a septic thrombosis is perfectly reasonable, and even excision of much of the thrombosed vessel, provided a streptococcal cellulitis is not threatened, would certainly cut short the disease and might well ward off the late complications.

Elevation and rest of the limb is ordinarily demanded, but I protest against the use of the ice-bag. It gives comfort, to be sure; but if it has

any action beneath the surface, it tends to retard the perfectly natural and desirable vascular reaction of the tissue to infection, if that is present, and it devitalizes the tissues. In many instances of deep thrombophlebitis and in the superficial disease, heat is clearly more favorable to the local reaction than cold. Moreover, heat is quite as grateful to the patient.

If, as I have suggested, the late complications of thrombophlebitis are due principally to lymph stasis, attention should be directed as early as possible to restoring the return of both lymph and blood from the leg. One should try to visualize the thrombotic process in each case. If it is attended by little fever and local tenderness, it will soon become absorbed, or organized and canalized, so that the fear of detachment of a clot



FIG. 5.—M. T. C. No. S. 27214. Late result of excision of ulcer and deep fascia in area of postphlebotic induration. Skin graft. Double "milk leg" six years earlier, which laid patient up for six weeks. Indurated areas developed on both legs, the right more marked. A previous excision without removal of deep fascia had already failed. Patient has slight bilateral varix. Removal of deep fascial strips in both legs is advisable.

by exercise after improvement has begun need hardly be entertained. Therefore, in the milder cases, exercise of the leg in an elevated position within a week or ten days after the process has passed its height should be begun. In severe infections, elevation should be maintained until fever has disappeared and local tenderness is absent. Then gentle motion in bed should be started. Later, light massage will be helpful. We are all too fearful of active exercises in an elevated position, forgetting to what the patient is subjected in the course of routine nursing, the use of the bedpan for example.

As the patient begins to get up, the leg should never be left dependent. Active motion is always more favorable to a return of fluid from the legs than relaxation. Periods of activity should be cut short enough to prevent

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tense swelling, and the rapidity with which swelling disappears on elevation gives some idea of the degree of permanent damage present. Bandaging is of little use unless it is beautifully done, but a light and not too tight elastic stocking may be helpful.

The late complications are rather fascinating subjects for surgery and a hint of the obvious indications for treatment has already been given. The tissues should be given new connections with the lymphatics beneath the muscular aponeurosis. To this end, strips of deep fascia should be excised beneath areas of superficial oedema and for some distance above and below them. When the superficial tissues are severely indurated or ulcerated, such a procedure is not enough. *The area most badly damaged should be excised, taking with it the underlying muscular aponeurosis.* Then a skin graft can be placed upon the delicate reticular tissues covering the muscles. (Fig. 5.) Experience alone can indicate what tissues should be excised and what may be treated by excision of fascial strips alone. In any one instance the procedure is so far a matter of judgment that the patient's consent for an operation in several sittings, perhaps, must be had. The tissues must be treated with exaggerated respect.

The results so far have been encouraging. Some patients have been very much improved, others only a little. None have been made worse. Further experience will show, I am sure, that the principle is sound, but technical improvements and, especially, earlier treatment of these peculiar lesions will lead to greater success. Moreover, treatment of the late complications of thrombophlebitis may doubtless to a considerable extent be anticipated when the relation of the lymphatics to thrombophlebitis is better understood.

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EMBOLECTOMY*

REPORT OF THREE CASES

By JOHN DEJ. PEMBERTON, M.D.

OF ROCHESTER, MINN.

FROM THE MAYO CLINIC

IN AMERICA to-day there is no established operative procedure of equal simplicity fraught with so little risk and with such dramatic potentialities that has been so woefully neglected as embolectomy for circulatory disturbances of the extremities. The reason this operation has not been employed more often can be readily explained by the fact that the rank and file of physicians either do not recognize the early symptoms of embolism or else are not acquainted with this method of reestablishing the circulation. Since September, 1927, I have performed arteriotomy with removal of obstructive embolus four times in three patients. The vessels involved were the common femoral, aorta at its bifurcation, common iliac, and superficial femoral. These cases are reported with the hope of stimulating further interest in this useful branch of surgery.

REPORT OF CASES

CASE I.—A man, aged fifty-six, came to the Mayo Clinic, August 31, 1927, for a complaint referable to the stomach and heart, which followed an injury that he received in February, 1925, when he fell from a roof sixteen feet high, striking the side of his head and shoulder. Following this accident he was in bed thirty-seven days; dyspnea was extreme on slight exertion, and there were certain qualitative dyspeptic symptoms. From the time of the injury he had been unable to carry on his work. According to the referring physician, röntgenologic examination showed a diaphragmatic hernia.

Before the patient was examined at the clinic he went to a hotel where he retired about 8 P.M. and went to sleep immediately. About 10 P.M. he was awakened by a severe pain in a cuff-like area about 10 cm. wide, just above the left ankle; it felt as though the bone were dry and would break. The foot was numb. Since April, 1927, he had been having one or two mornings a week, a sensation similar to this one, which would disappear after he had put on his shoe. On this occasion he put on his shoe, but the foot remained asleep and the pain continued. The longer he walked about, the more severe it became. There was some swelling, beginning in the ankle and gradually progressing to the knee. The entire left leg was tight and painful, and was covered by black and brown blotches. About midnight he was unable to stand on the foot. He did not call a physician, however, until early in the morning, when he was immediately taken to the hospital.

I saw the patient about 11 A.M., and found him in what seemed to be a critical condition. He was prostrated, extremely dyspneic, and was suffering excruciating pain in the left leg; there was marked auricular fibrillation (rate about 160). There was bluish discoloration in blotches over the leg, beginning at the foot and ending in an irregular line just below the groin. (Fig. 1.) The movements of the foot and leg were limited. The surface temperature of the leg was decidedly lower than that of its

* Read before the Southern Surgical Association, December 13, 1927.

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fellow, and the only pulsation that could be detected in the leg was over the femoral artery, just below Poupart's ligament. Embolus of the femoral artery was diagnosed, and about fourteen and a half hours after the onset operation was performed under local anæsthesia.

At the point of origin of the profunda, the femoral artery bulged for about 2 or 3 cm. and below this point the superficial femoral artery was narrowed. At the point of bulging the consistence of the vessel was definitely increased; it was incompressible and on palpation appeared to contain solid or semisolid material. The pulsation of the artery ceased at this point. Through a longitudinal incision 2 cm. long, the anterior wall of the artery was opened and two fairly well-organized blood clots extruded immediately, the larger prong-shaped probably 3 or 4 cm. long, the smaller irregularly spherical. (Fig. 2.) After expulsion of the clots there was free bleeding from the mouths of the common femoral, the profunda femoris, and the superficial femoral, the patency of these vessels being thus evident. The opening in the vessel was closed immediately with a running suture of 000 silk which had been previously immersed in liquid vaseline and threaded on a No. 12 sewing needle that had been ground down to a length of a little more than 1 cm. (Fig. 3.) Pressure was then released from the vessel proximally and distally; no bleeding followed. Wound closed, but an untied fish-line silk ligature was left around the common femoral artery above point of opening, to control any secondary bleeding that might occur.

Immediately after the operation there was improvement in the condition of the leg. The color returned to normal except in the foot and for a distance of 12 or 15 cm. above the ankle. This area was decidedly more cyanosed than before the operation and the patient complained of considerable pain. Heat was applied to the leg and treatment by diathermy instituted. The cyanosis gradually disappeared, so that after the lapse of thirty-six hours the leg had resumed normal color. Convalescence was practically uneventful, the patient was out of bed on the twenty-third day and was dismissed on the thirty-eighth day after the operation.

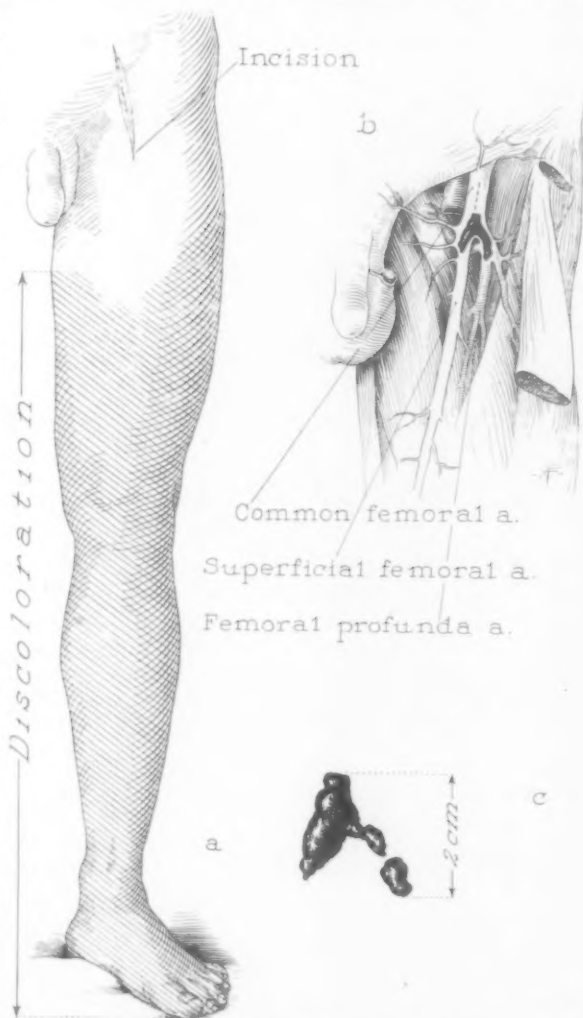


FIG. 1.—a, The extent of the area of ischemia and discoloration; b, Clot *in situ* blocking superficial femoral and femoral profunda arteries; c, Embolus removed. (Case I.)

After complete cardiologic examination the diagnosis was made of angina pectoris, severe coronary sclerosis and marked myocardial degeneration. The electrocardiogram showed auricular fibrillation (rate 114) with ventricular premature contraction, left ventricular preponderance, and inversion of the T-wave in all three leads.

CASE II.—A housewife, aged thirty-five, came to the clinic, September 22, 1927, because of convulsions. At the age of fifteen chorea developed and since then she had had shortness of breath and slight œdema of the feet from time to time. Her health had been good until May, 1926, when abortion occurred after two months of pregnancy.

Common femoral a

Femoral v

Sartorius m.

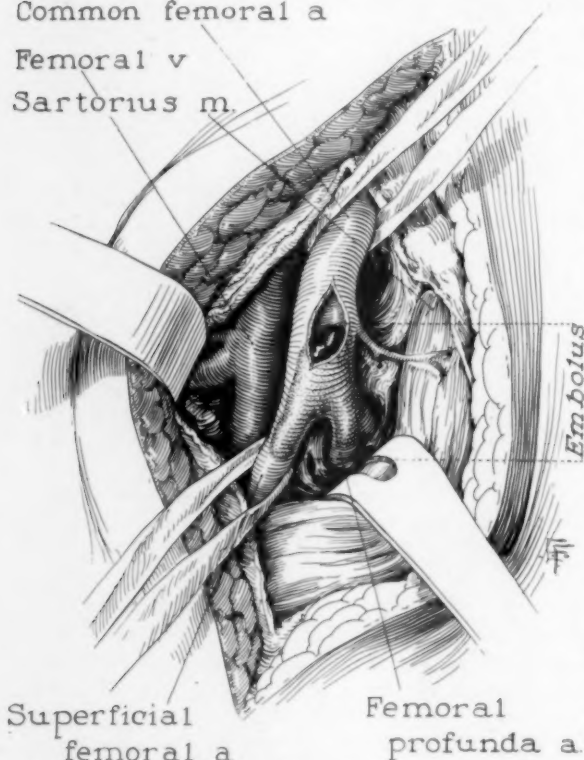


FIG. 2.—Exposure of common femoral artery showing embolus in situ. (Case I.)

Seven days later, while she was sitting in a chair, she suddenly felt faint and the entire left side became paralyzed; her mouth was drawn and she was aphasic. After two days she was able to speak and move her limbs; in three weeks she was up and about. The left side, however, remained weak for several months. Beginning in August, 1927, "spells" had occurred that were characterized by a peculiar feeling of heaviness in the head, a weak voice, and partial loss of hearing. During attacks she usually wanted to lie down. There had been no convulsions or loss of consciousness. The attacks varied in duration from three minutes to two hours and were followed by dull frontal headache and vomiting. The interval between the first and second attack was about three months, but the attacks became progressively more frequent and of longer duration. With the

last seizure, September 19, 1927, she frothed at the mouth, bit her tongue and rolled her eyes. After this attack she was apparently dazed and aphasic for awhile.

General examination in the hospital showed a fairly well-developed and well-nourished woman, who appeared to be in a semi-dazed condition. The patient was apparently able to comprehend questions, but answered only after they had been put to her several times. Her answers were intelligent but her voice was feeble and indistinct. The temperature and pulse were normal. The systolic blood-pressure was 110, and the diastolic 74. There was a systolic murmur at the apex. There was no œdema. The blood count, blood Wassermann test and analysis of the urine were essentially negative. Ophthalmologic examination showed ocular movements, pupil reflexes and ocular fields essentially normal, and fundi negative. September 26, 6 c.c. of clear normal cerebral fluid was removed; the pressure was 1 cm. and there was prompt response to jugular pressure. A diagnosis was made of chronic endocarditis with mitral stenosis and ancient cerebral embolism.

October 1, the patient was out of bed and had been walking a little. About 8 A.M.,

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while sitting in a chair, she was suddenly seized with severe pain in the legs. About 11 A.M. the pain finally settled in the right leg. Examination at this time showed extreme marble-like blanching from the foot to the knee, except for two areas of bluish discoloration on the dorsum of the foot. The temperature of the right leg was definitely lower than that of the left. Pulsation could not be palpated in any of the vessels on the right side and sensation in the foot and leg to the knee was definitely diminished. Blood did not follow deep needle puncture of the foot. There were no movements in the foot but the patient was able to bend the knee. There was no area of tenderness or diminution of power in the left leg. There was no distinct pulsation of the left femoral artery, but on auscultation there seemed to be a faint sound over it. Slight bleeding followed needle puncture of the foot. A diagnosis was made of an embolus in the common iliac and operation was advised. On account of the patient's peculiar mental status, it was impossible to get her consent for several hours, and operation was delayed until 3 P.M., seven hours after the onset of the first symptoms.

Under local anaesthesia an incision about 8 cm. long was made over the right common femoral artery and the artery was exposed just below Poupart's ligament. There was no pulsation, and the artery was narrowed to about half normal size; clots were not palpated. (Fig. 4.) A vertical incision, about 2 cm. long, was made in the anterior wall. Immediately there exuded parts of a soft thrombus. Small curved duct forceps were inserted distally and more of the soft thrombus was removed; only slight bleeding followed. There was no bleeding from the proximal end. Forceps and a uterine probe were passed up into the lumen of the external iliac, the forceps for a distance of about 13 cm. and the probe for 20 cm. The probe at this point seemed to meet with an impassable obstruction. The incision in the skin was carried up for 10 or 15 cm. on the abdominal wall. The aponeurosis of the external oblique was divided, the internal oblique fibres were separated, and the external iliac artery exposed and then traced with the fingers by pushing the peritoneum ahead. At a point near the promontory of the sacrum, pulsations of the abdominal aorta could be distinguished. Below this point the common iliac was milked and something was felt crunching between the fingers. After further milking, it was evident that the embolus was dislodged into the common iliac, for the pulsations were now more distal than was noted at first. The forceps were pushed up into the artery as far as possible, the jaws closed, and then withdrawn; with it there came a long branched thrombus about 7 or 8 cm. long, evidently from the iliac and its two branches. (Fig. 5.) Immediately a large irregularly cone-shaped clot (embolus), about 3 by 5 cm., shot out of the artery followed by an unimpeded stream of arterial blood. There was no bleeding from the distal end of the femoral artery, which was gently probed downward without meeting obstruction for from 10 to 12 cm. The opening in the artery was closed by a running suture of 000 silk threaded on a fine straight artery needle. Pressure was released from the artery proximally, and slight

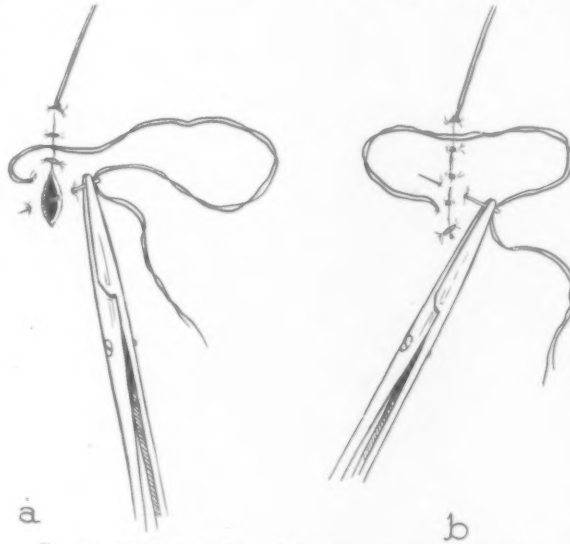


FIG. 3.—Method of closing arteriotomy wound. (Case I.)

bleeding from the suture line followed. A second row of silk was then placed in the artery; there was no bleeding. The wound was closed, an untied fish-line suture being left around the femoral artery, proximal to the suture line. The ends of the thread were brought out of the wound so that they could be tied if secondary hemorrhage occurred. After the operation a faint pulsation was felt in the popliteal. The color of the skin over the foot was now changed from blanched to mottled blue; the patient was able to move the foot and toes.

Immediately on the patient's return to bed, external heat in the form of hot water bottles and medical diathermy was applied to the right leg, and normal color and motility were soon restored. How-

ever, she then began to complain of severe pain in the left leg, worse around the knee. The possibility of a second embolus was considered, but since there was no appreciable change in the color of the leg or in the sensation or motility, a definite diagnosis could not be made, even though one could not be sure of obtaining the femoral pulse. The leg was examined at intervals of half an hour to an hour during the course of the evening and night, and there was no change until about 3.30 A.M. when definite blanching of the foot and leg up to the knee, with loss of motion and sensation occurred. The leg was bluish and mottled; the extremity had a post-mortem lividity, and was cold up to the knee. The foot was in a

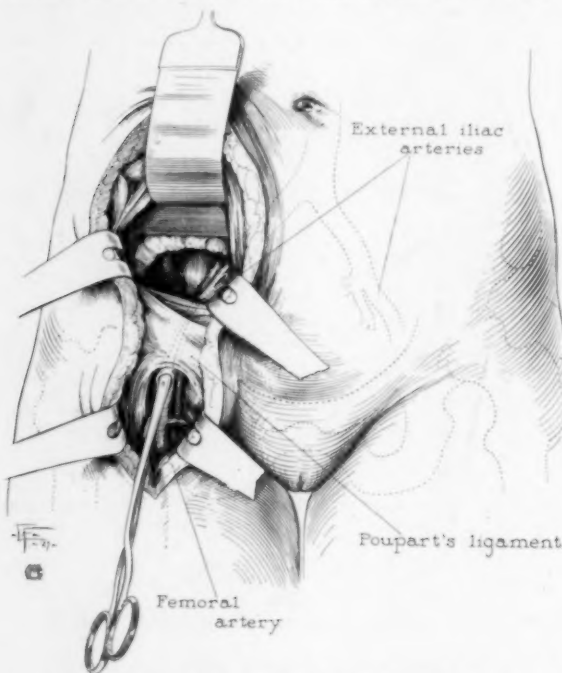


FIG. 4.—Method of approach for the removal of an aortic embolus. (Case II.)

rigid "drop" position. Operation on the left leg was urged, but the patient refused. Later, however, she consented, and at 9.30 A.M., about twenty-five and a half hours after the onset of symptoms of partial occlusion, and about six and a half hours after the onset of symptoms of complete occlusion, the operation was performed under local anaesthesia.

The upper part of the left common femoral artery was exposed in a manner similar to that on the right side. The artery, which was collapsed, was opened, and only a small amount of soft thrombus came out. Probing with gall-duct forceps for 12 to 16 cm. was not followed by free bleeding, so the incision was carried up over the abdomen and the external iliac exposed retroperitoneally. In doing this a small opening was made in the peritoneum; it was closed immediately. With the probe as a guide, the artery was traced by the finger as high as its bifurcation, where pulsation could be felt. (Fig. 6.) By milking the artery, the pulsation came more and more distally until the embolus (a flat clot about 0.5 by 2.0 by 0.5 cm. rolled up into a cone-shaped plug) was withdrawn. Free bleeding followed immediately. The opening in the femoral artery was then closed, with some tearing of the wall; in order to get tight approximation the lumen was necessarily constricted. Before closure it was noticed that the intima of the artery on the posterior wall opposite the incision was injured. After closure, pulsation came

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through, but before the wound was closed this had ceased. Accordingly, the artery was opened at a point about 4 cm. below and the thrombus removed, but about as soon as the artery was closed there was further clotting in the vessel at the point of the first opening. The stitches in the lower or second wound were removed, a second clot extracted and the incision again sutured. Pulsation continued for about five minutes, then ceased. As further probing did not seem warranted, the wound was closed.

Following the operation the patient was in a state of considerable shock. The temperature and pulse rose rapidly, the temperature mounting to 106° F. She grew progressively worse and died about ten hours after the operation. Until death, the circulation in the right leg and foot remained good. The condition of the left leg, however, was not improved by the operation.

Necropsy showed chronic rheumatic mitral endocarditis with stenosis, multiple embolic infarctions of the brain and kidneys, cholelithiasis and chronic pericarditis. The aorta and both the iliac and femoral arteries were dissected out and the lumen of the right iliac and both femoral arteries was entirely free, without evidence of thrombus at the suture lines. (Fig. 7.) On the left side, however, a fairly well-organized thrombus extended from the beginning of the iliac down through the femoral distal to the suture line.

CASE III.—A woman, aged sixty, entered the Mayo Clinic, October 31, 1927, because of goitre and heart trouble. She stated that the goitre had been present for twenty years and that it had diminished slightly in size during the last three or four years. She had been slightly breathless for the last four years and the blood-pressure had been high for about the same time. For approximately two years the heart beat had been rapid and had palpitated much worse during the last four months. There was also a certain degree of heat intolerance and increased perspiration. The appetite was always good and there was no gastro-intestinal disturbance. She had gradually lost twenty-six pounds during the last three years and had become rather shaky. She had been more dyspnoëic in the last year and had to sleep with several pillows under her head. The ankles were sometimes slightly oedematous. Since July she had been in bed a good deal. She had a fright June 28, 1927, and had partial aphasia for about two weeks. Her husband thought she had had a stroke. There had been no paralysis, however. Iodine (Lugol's solution 30 to 45 minims daily) had been given most of the time since July; also varying amounts of digitalis. A distressing cough with slight mucoid expectoration had been present for the last six months.

Examination in the hospital showed an exhausted patient with dyspnoëa and considerable orthopnoëa; the lips were slightly cyanotic. There was considerable vascular sclerosis. The skin was warm and moist. There was marked weakness of the quadriceps, a large adenoma of left lobe and the isthmus of the thyroid and also enlargement

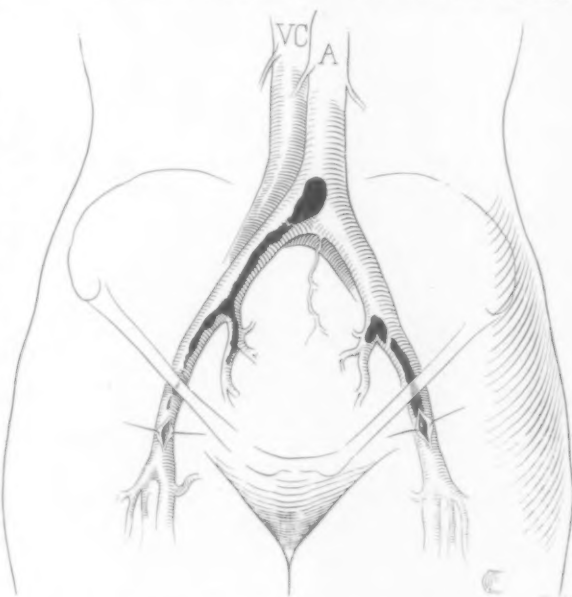


FIG. 5.—Diagrammatic sketch of condition found in Case II, aortic embolus with secondary thrombus formation in the right iliac, and left common iliac embolus.

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of right lobe, but no bruits. The heart was moderately enlarged to the left, there was rhythm of auricular fibrillation, and the apical rate was 132 without pulse deficit when the patient was lying down. The systolic blood-pressure varied from 180 to 190, and the diastolic from 92 to 96. The liver was not definitely palpable. There was slight œdema over the tibias, tremor of the left hand, more noticeable on movement, and the small joints of the fingers were enlarged. The basal metabolic rate was 49. The blood count, the blood Wassermann test and the urinalysis were negative. Röntgenograms of the chest showed that the heart was moderately enlarged and that there was some passive congestion. A clinical diagnosis was made of adenomatous goitre with hyperthyroidism,



FIG. 6.—Sagittal section; method of "milking" down an aortic embolus through a retroperitoneal approach. (Case II.)

essential vascular hypertension with general cerebrospinal arteriosclerosis, myocardial degeneration with partial decompensation and residuum of cerebral vascular accident.

The patient was kept at rest and given Lugol's solution, 10 minims three times a day. There was some improvement until the twenty-second day after admission, when the heart began to fibrillate more rapidly, and the patient complained of sudden pain in the left foot and anterior part of the left leg. The pain was continuous and it was described as a burning, tingling sensation as though the foot and leg were asleep and circulation was returning. Examination at this time showed the left leg colder than the right. There was no blanching but there was a slight suggestion of cyanosis. The superficial veins in the left leg stood out more prominently than those in the right. There was no pulsation in the left dorsalis pedis or in the posterior tibial, but pulsation in the left popliteal appeared to be definitely diminished. The foot and leg remained this way for four days, when the patient complained of sudden severe pain, most marked in the foot and anterior tibial region. The pain was continuous and of a burning type. The patient was flushed and sweaty; she appeared to be in great agony. Auricular fibrillation was rapid. The left leg up to the level of the knee was markedly cyanotic, there was

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extreme tenderness and it was cold to the touch. She was able to move the foot and toes only slightly. The entire leg to a point above the knee was definitely colder than its fellow. Pulsation of the femoral artery was felt from its origin down to the point of its entrance into Hunter's canal. There was no pulsation of the popliteal or any of the vessels in the leg. A diagnosis was made of embolus of the left popliteal artery.

Three hours after the last attack of pain, five days after the onset of circulatory disturbance in the leg, operation was performed under local anaesthesia. The popliteal artery was exposed through an incision approximately 20 cm. long. The vein was partly thrombosed and the entire popliteal artery was thrombosed and seemed almost as hard as a lead pencil. The artery was opened and a long thrombus, partly organized that is, presenting a mottled reddish-gray appearance, was removed piecemeal by forceps and a probe, and finally, by injection of citrate solution it was possible to open the lumen of the lower femoral artery so that a full stream of blood under normal pressure spurted from the arteriotomy wound. It was impossible to remove the thrombus of the distal popliteal and tibials, therefore, a second incision in the artery was made, about 6 or 7 cm. below the first, but still it was impossible to remove much of the clot. Finally, after about ten minutes, in exploration of the distal artery, the proximal opening in the artery was sutured and after the clamp on the artery was released there was no bleeding from the opening, owing to reformation of the thrombus. Further probing of the femoral artery through the distal opening was made, but bleeding could not be obtained again. Undoubtedly the clotting was taking place almost as fast as the clots were removed. It was impossible, therefore, to do anything further in the way of removing the clot. The popliteal vein was ligated in order to increase the collateral circulation in the distal part and it was found that there was some recent clotting in the popliteal vein. Prognosis seemed hopeless as regards saving the limb, or the patient's life on account of the condition of the heart. Her general condition was not greatly affected by the procedure, and on following day circulation of foot and leg appeared slightly improved, but it was obvious that gangrene of foot would inevitably follow. On fourth day after operation signs of pneumonia developed and she died about twelve hours later.

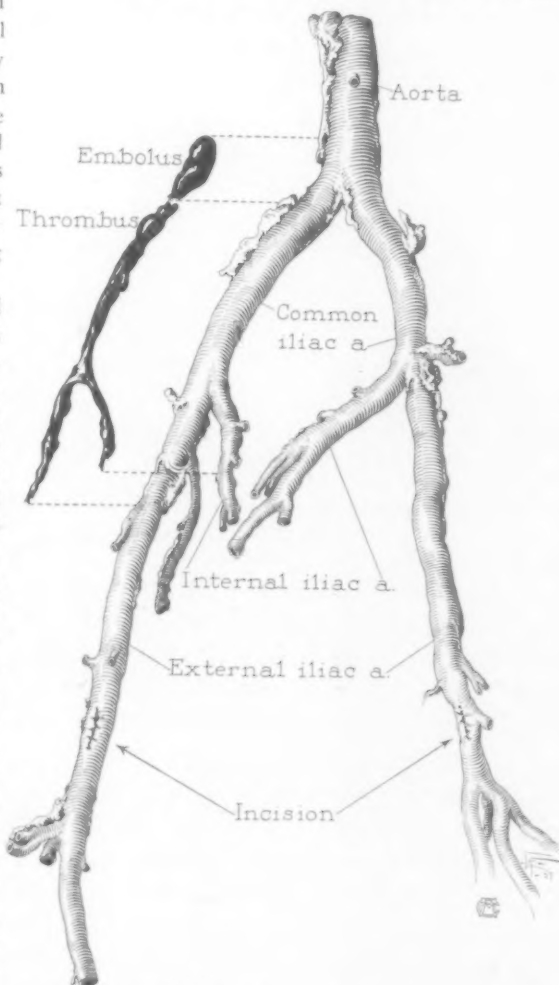


FIG. 7.—Portion of arterial tree removed at necropsy to illustrate the relative positions of the embolus and the arteriotomy wound. (Case II.)

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Surgery of blood-vessels is of comparatively recent development and the number of operations recorded for the removal of obstructive arterial emboli are not numerous. The first attempt was made in 1895 by Ssabanejew. He opened the femoral artery because of threatening gangrene of the leg, but failed to find the embolus. Two years later Moynihan removed an embolus from the popliteal artery. The patient died four days later. In 1907, Stewart performed arteriotomy and extracted an embolus of thirty-six hours' duration from the femoral artery. Circulation to the limb was reestablished temporarily, but forty-two days later it was necessary to amputate the leg below the tubercle. In the same year Doberauer removed an embolus from



FIG. 8.—Embolus forceps, devised for the removal of the emboli inaccessible to direct approach.

the axillary artery, fifty-two hours after its lodgement. Thrombosis followed and two days later he made an arteriovenous fistula between the axillary vessels with the idea of restoring circulation to the hand. In this year Trendelenburg made a bold attempt to remove a pulmonary embolus. In 1908, Proust and in 1909, Schiassi, Murphy, and Carrell and Leriche, performed arteriotomy for the removal of emboli from the vessels of the extremities, but none was successful in reestablishing the circulation.

The first embolectomy carried out with good results was that of Lahey, performed in 1911. In the following year Key performed the second successful operation, and to Key belongs the credit for developing this field of surgery. It is estimated that up to the present time less than 150 cases of embolectomy have been reported in the literature. Most of the operations have been performed by Scandinavian surgeons; there were ninety-five in Sweden from 1912 to 1925 inclusive. In this series were seventeen operations on fifteen patients by Key. Less than twenty operations have been reported from the United States, Canada and England. All of these were performed for circulatory disturbances in the extremities and the vessels involved included the aorta at its bifurcation, the iliac, femoral, popliteal, subclavian, axillary, brachial, ulnar and radial arteries.

Origin of Emboli.—The possible sources of arterial emboli in the general circulation are: (1) A central spot in the arterial tree; (2) the left side of

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the heart; (3) the pulmonary veins; (4) the right side of the heart, and (5) the systemic veins. In order that an embolus may lodge in the general arterial circulation from the right side of the heart or systemic veins, there must be a patent foramen ovale; the embolus is then spoken of as a "paradoxical" or "cross" embolus. Nyström recently reported a verified case of paradoxical emboli arising from thrombosis of the iliac veins and lodging in both common iliac arteries. After the emboli had been successfully removed the patient died from cerebral and pulmonary embolism. Necropsy revealed a patent foramen ovale, thrombosis of iliac veins and cerebral and pulmonary emboli. Of the cases reported in the literature in which operation was performed the heart was diseased in more than 80 per cent. Willius has found that cardiac emboli occur in about 25 per cent. of all patients dying from disease of the heart. While emboli are prone to occur in endocardial valvular disease, particularly mitral stenosis, he shows that no form of heart disease is free from the perils of embolism. Willius explains the frequency of mural thrombosis in the auricles in auricular fibrillation by the fact that these chambers are no longer dynamic, and thus favor stasis and the development of coagulation of the blood elements. Bull examined more than 6000 necropsy records at Rik's Hospital, Oslo, with the view of ascertaining the number of cases of embolism of the extremities with or without gangrene, and of determining the primary thrombus. Embolism of the extremity occurred fifteen times, fourteen times in the lower extremity and once in the upper; in seven of these cases there was no gangrene. The thrombus was in the cardiac chambers in thirteen cases and in the aorta in the other two. Among 6140 necropsies thrombosis was found in the arteries and heart in 243 cases (about 4 per cent.), in the aorta only in nine cases (advanced atheroma), in the pulmonary veins in three cases, and in the heart, involving the valves, or more frequently in one or more of the chambers (right side in sixty-seven cases, left side in sixty-three cases, both sides in fifty-one cases). Commenting on the frequency with which thrombosis is found in both sides of the heart, Bull emphasizes that a patent foramen ovale is not necessary to explain the simultaneous occurrence of emboli in the pulmonary and general circulation.

Embolism of an extremity may follow an operation or an infectious disease when there is no demonstrable lesion of the heart. It is probable that low-grade infection is an important causal factor of all emboli. On the basis of such speculation the marked variation in secondary thrombus propagation following the lodgement of an embolus could readily be explained by the difference in the virulence of the infecting organism.

It is difficult to determine the incidence of embolism of the large arteries of the extremities but undoubtedly it is higher than is generally believed. In approximately 200,000 registrations in the Mayo Clinic, the histories and data regarding twenty-one cases of circulatory disturbances of the extremities were definitely the result of obstructing arterial embolus. In three others the data were suggestive of embolism.

When a thrombus is detached from the wall of the heart, it is caught in the current of the blood stream and carried rapidly out through the arterial channels until it reaches a point of narrowing of the artery, such as a bifurcation or where a large branch is given off. Here the embolus lodges and owing to the fact that its shape is then molded by secondary thrombosis to conform to the contour of the lumen of the vessels, the clot is often found at operation to be saddle-shaped or prong-shaped or to resemble a molar tooth. For this reason the embolus will probably obstruct not only the principal artery, but its main branch, thus diminishing the chances of the establishment of adequate circulation to the extremity. If the blockage is not removed early by embolectomy a secondary thrombus forms as a rule distal to the clot, thus interfering with collateral circulation, as illustrated in Case III. Five days before operation there were definite symptoms of embolism in the femoral artery with pain, blanching of the foot and diminished pulsation in the popliteal artery, indicating either incomplete or complete blockage with efficient collateral circulation. This condition remained about stationary until three hours before operation, when pain became more severe, popliteal pulsation ceased, and evidence of impending gangrene appeared. Operation revealed extensive secondary thrombosis. However, the tendency to secondary thrombus building is not constant in all arterial emboli, for occasionally adequate collateral circulation is established and the vitality of the limb preserved.

Symptoms.—The characteristic symptoms of embolism are those of ischæmia of the extremity. The subjective symptoms are sudden severe stabbing pain, a sensation of cold and numbness, and disturbance of sensibility. The objective symptoms are change in color of the skin, which becomes marble-white, blotchy, ashen or cyanotic, decrease in the temperature, disturbed motility, absence of skin and tendon reflexes and absence of pulsation. The sudden blockage of a large artery will throw an additional burden on the heart, which if already injured may result in great prostration, with tachycardia, fibrillation, cyanosis and dyspnoea. Key states that there may be, before the onset of circulatory disturbances, certain prodromal symptoms due to small emboli. Not infrequently in cases of femoral embolism the patient first complains of pain in both legs, then with the appearance of the ischæmia the pain is confined to one leg. It is believed that the embolus is arrested momentarily at the aorta, straddles the bifurcation and thereby produces partial obstruction to both iliac arteries.

Diagnosis.—The diagnosis is readily made if the obstruction is complete. However, the condition must not be confused with venous thrombosis in which the extremity is warm, cyanotic and swollen, pulsation is present, sensations are unchanged and the veins are often painful. The circulatory disturbances of the extremity from arterial thrombosis due to endarteritis obliterans or arteriosclerosis are readily differentiated by the presence of prodromal symptoms and the slow extension of the process observed in these

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conditions. Functional circulatory disturbances are not likely to be confused with embolism.

Localization.—As the embolus is generally found lodged at the bifurcation of branching of the vessel and as the obstruction is always central to the upper limits of the area of ischæmia, the localization of the clot usually offers but little difficulty. Furthermore, in many instances the point where pulsations cease can be determined by palpation; if patients are very thin even the nodular enlargement of the vessel produced by the embolus may be palpated. Difficulties of localization may be encountered in the presence of multiple emboli, secondary thrombus formation, and in cases of embolus at the bifurcation of the aorta which may completely obstruct one common iliac artery and only partially obstruct the other, resulting in indefinite symptoms on that side. The latter condition was noted in one of Key's cases, also in my Case II.

Treatment.—The treatment may be divided into surgical and non-surgical. The non-surgical treatment consists of the application of heat to the extremity with the hope of favoring the establishment of collateral circulation, or vigorous massage of the limb over the site of the embolus with the idea of breaking up the clot, thereby permitting its distribution to smaller peripheral vessels. While successful reestablishment of the circulation has followed both of these procedures, the non-surgical method should be considered only when a very small vessel of the extremity is involved with little evidence pointing to impending gangrene or if the patient is critically ill and unable to stand any operative procedure. Before advising the employment of non-surgical treatment it should be borne in mind that the blockage of the principal artery of an extremity by an embolus is laden with greater danger of gangrene than a similar blockage by a ligature. If a vessel is obstructed by an embolus two other factors diminish the chances of the establishment of collateral circulation: the embolism is likely to be lodged at the point of origin of a large vessel and as a rule obstructs it as well as the principal artery of the extremity, and an embolus is more likely to propagate the formation of thrombi than is a simple ligature.

The surgical procedures that may be indicated are arteriotomy with the removal of the obturating clot, and ligation of the vein accompanying the obstructed artery. Embolectomy, performed as soon as possible after the onset of the obstruction is the ideal procedure. Delay in removing an embolus increases the chances of thrombosis in the artery, and decreases the vitality of the tissues of the extremity by continued suspension of the circulation. The presence of either of these complications lessens the chances of success of the operation. As emphasized by Key, the operation should be employed in all cases in which circulatory changes are threatening and also in cases in which there is beginning gangrene: in the first instance to prevent the development of gangrene, and in the second to restrict its spread.

The operative technic is simple. Under local anaesthesia the artery is

exposed and incised at or just above the site of the embolus and the obturating clot or clots are removed with the least possible injury to the intima. If the operation is prolonged, the edges of the wound are kept moistened by compresses soaked in 2 per cent. solution of sodium citrate. The wound in the vessel is closed by interrupted or continuous suture of 000 silk, which has been immersed in liquid vaseline and threaded on a No. 12 sewing needle, ground down to about 1 cm. long. When the iliac artery, the aorta at its bifurcation, or the subclavian artery is involved, direct approach is difficult if the patient is obese, and inadvisable if the patient is in poor condition. In such case it has been suggested that the incision in the artery be made at a point easy of approach, such as the femoral or the axillary artery; then if the vessel is gently probed at a point nearer the heart, the clot may be dislodged and removed through the opening in the femoral or axillary artery. (Figs. 6 and 8.) There are published reports of successful removal of an embolus at the bifurcation of the aorta by means of both the direct transperitoneal approach and the indirect retrograde probing. Certainly if the patient is obese or critically ill, the latter method is to be preferred. If it is impossible to dislodge the clot by probing, this method may be supplemented by exposing the iliac artery and the aorta retroperitoneally and gently milking the vessels until the embolus is dislodged. The aortic embolus in Case II was successfully removed in this manner through an opening in the right femoral artery. The patient died from secondary thrombosis in the left common iliac, the result of failure to expose and open the left femoral artery at the time of the right femoral arteriotomy. Key emphatically urges this procedure because of the frequency with which an aortic embolus plugs the opening of both common iliac arteries. Late in the case when it is impossible to reestablish the circulation on account of injury to the intima caused by prolonged contact with the thrombus, the collateral circulation may be improved by ligation of the companion vein at the site of the arterial obstruction or preferably at a more central point. Makins proved conclusively that when the principal artery to an extremity is blocked, the ligation of the companion vein materially increases the blood-pressure in the distal parts. Holman showed further that the blood-pressure will be raised still higher if the vein is ligated at a point equidistant to the arterial obstruction.

Results.—The results of embolectomy are influenced by certain factors: (1) The time elapsing between the lodgement of the embolus and its surgical removal; (2) the number of emboli; (3) the condition of the patient, and (4) the vessel obstructed. In the literature there is only one record of successful restoration of the circulation in any case of twenty-four hours' duration or longer; Key recently reported a successful result following surgery for an axillary embolus of forty-eight hours' duration. Jefferson reviewed the records of twenty-eight cases of embolectomy performed in the period between 1922 and 1925. The results were satisfactory in fifteen. Most of the operations were performed in the Scandinavian countries where

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the influence of Key's teachings is greatest. Of the seventeen operations of embolectomy performed by Key since 1912, eight were successful. This is an excellent record, for as summarized by Jefferson, "in the nature of things a very high percentage of successes is unlikely ever to be attained, for emboli are apt to be multiple and further infarction elsewhere will sometimes carry off the patient in whom a local success has been won; moreover, the advanced age of the patient and the frequency of heart disease often make the subjects bad surgical risks."

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ARTERIAL EMBOLLECTOMY *

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THIS paper is based upon a study of ninety-five cases of embolectomy gathered from the literature of American, Canadian, English, Swiss, French and Scandinavian surgeons and a report of three cases operated upon by the author, making a total of ninety-eight cases.

The removal of an embolus from an artery has been made possible through the development of the modern technic of blood-vessel surgery. The first attempts were unsuccessful probably on account of lack of proper understanding of the principles underlying the surgery of blood-vessels, and also because in most of the cases that came to operation the circulatory disturbance was too far advanced. Restitution of circulation could not be obtained and amputation for gangrene of the limb was the usual result.

It is only within the last decade that arteriotomy for embolectomy has begun to give encouraging results. The first arteriotomy for the removal of an embolus was performed in 1895 by Suabanejew for threatened gangrene of the leg. The femoral artery was opened, the embolus removed, but the operation was not successful.

Several surgeons had tried to remove emboli or arterial thrombi during the decade following its first performance, but were not successful. In 1909, Dr. John B. Murphy removed an embolus lodged in the common iliac artery near the bifurcation of the aorta. The operative diagnosis was thrombosis of the left femoral and an incision into that artery was made, but after opening the vessel, it was found that the obstruction was higher up. By means of a ureteral catheter introduced into the femoral artery as far as the bifurcation of the aorta, he was able to dislodge the obstructing clot. The opening in the artery was then closed with fine silk sutures threaded on a conjunctival needle. The operation was unsuccessful, gangrene developed, and amputation of the leg was necessary.

The first completely successful embolectomy was performed by Labey in 1911. He removed an embolus from the femoral artery six hours after its appearance. Dr. Einer Key of Stockholm, whose publication in 1922 is considered to be the most important contribution to the subject, performed the second successful embolectomy one year later. In his case the embolus was also lodged in the femoral artery. Since that time Key has performed this operation ten times on nine patients. In eight out of his ten cases, the emboli were located in the lower extremity and two in the upper extremity. Gangrene appeared in four of the operated cases and the result was good in the

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remaining six. He collected fifty-one other cases from the literature and he states that in no instance has the operation been fully successful when it was performed more than twenty-four hours after the onset of the obstruction. In reviewing the literature since the publishing of Key's paper in 1922, we found a report by Lian and Maure in 1925 in a case of axillary obstruction of twenty-nine hours' duration.

Early diagnosis and immediate surgery is advocated by all. The best results were obtained in those cases where the operation was performed within the first twelve hours after the onset of the obstruction. The sooner embolectomy is carried out after the onset of the condition the better are the prospects of success. If no attempt is made to dislodge the clot until the lapse of a few hours after its onset, secondary thrombi will form and cause obstruction to a large segment of the arterial canal. Degenerative changes may take place in the intima of the vessel at the site of the thrombus or embolus. These changes interfere with the flow of blood within the lumen of the vessel, even after the clot has been completely removed.

Most of the early cases were reported by Scandinavian surgeons, but since the publication of Key's paper, we notice from a review of the literature that there is a slow but steady increase in the number of cases reported by American and continental surgeons. But the reports from the Scandinavian literature still predominate over that of any single individual country.

The subject is worthy of discussion from many angles. This condition is not of a very frequent occurrence and it is not usually recognized in its early manifestations by the general practitioner or surgeon. The importance of early surgical intervention is not fully appreciated. Early recognition of its symptoms, and a prompt diagnosis are essential, if satisfactory results are to be obtained by operative interference. The technic of the operation is not very complicated or difficult, because the emboli usually lodge in vessels that are most accessible. As we shall see from report of the cases, most of the emboli were in the large vessels of the upper or lower extremities and mostly near the bifurcation points such as the profunda brachialis or profunda femoris. The localization of the embolic site is not difficult to establish, particularly in the vessels of the extremities where the presence or absence of pulsation can be ascertained so easily.

The symptoms that usually characterize an embolus may be divided into the subjective and the objective. The subjective symptoms are, sudden onset of pain, a sensation of coldness and numbness of the extremity. The pain may be very severe with onset of obstruction and gradually diminish in intensity as the blood supply to affected part is progressively lessened. The objective signs are, change in color of the skin, the lowering of the temperature of the affected part, some disturbance of motility, and the most important of all, the absence of pulsation in the artery supplying the affected part.

As a result of the suspension of circulation, there is a marked anemia of the affected extremity. The skin becomes pale and somewhat cyanotic. As the obstruction continues, the discoloration may be seen, in livid, dark blue

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patches. Motility is restricted and may be entirely suspended depending upon the degree of circulatory disturbance.

In one of my own cases, I was able to locate the embolus definitely in the brachial artery at about the upper third of the forearm before the incision was made. Palpation demonstrated a small segment of the vessel which had a solid cord-like resistance with pulsation above that point and absence of pulsation below it. In another case, the embolus was lodged in the axillary artery and its location was not difficult to ascertain. In both of these cases, the arteries were easily palpable.

In following the course of an artery where an embolus is suspected of having lodged, one usually notices an absence of pulsation at a certain point. Where the pulsation ceases one may notice a slight bulging or dilatation of the vessel and a sense of resistance within the lumen. The vessel below the point of obstruction is of a distinctly smaller calibre.

In the author's case where the embolus lodged in the brachial artery it was possible to palpate it within the lumen after the artery was exposed and dislodge it upward and downward for a short distance by gently milking the artery digitally. The diagnosis may be difficult in cases where the embolus saddles a bifurcation and is not obstructing the circulation in the beginning and where the arterial disturbance is slowly progressing due to the formation of a secondary thrombus at the embolic site.

It is important to differentiate between an embolus and a thrombus in an artery which is due to an arteritis. In attempting to make a differential diagnosis between these two conditions, one must take into consideration the predisposing causes. In an embolus, the onset is usually sudden. There is a history of organic heart disease or the existence of an acute infectious illness, or closely following upon a surgical operation. In an arterial thrombus, we will usually elicit a history of long standing premonitory symptoms such as a sensation of coldness and of numbness, cyanosis of the peripheral parts of the extremity.

The operation of arteriotomy should always be performed under local anaesthesia. Most of the patients suffering from this disease are usually of low physical resistance, suffering from either poor heart action or septic diseases. It is important that the risk of the operation should be minimized to the fullest extent. Furthermore, as shown before, most of the operations usually have to be performed on vessels that are easily accessible and can be well managed under local anaesthesia.

The technic of the operation must be carried out very scrupulously. After the site of the obstruction is located, the vessel is isolated and lifted from its bed. Small rubberized clamps may be applied at a point above and below the obstruction. Some recommend the constriction of the vessel with a fine rubber tube, while others advise digital compression. My own procedure was to raise the vessel from its bed and constrict it above and below the embolus by means of an ordinary flat sterilized tape.

The vessel is incised longitudinally a little below or above the point of

obstruction and the clot evacuated. This can be done by pulling gently on the clot with very small forceps covered with sterile vaseline or dipped in 2 per cent. citrate solution, or fine scoops may be used. Milking the vessel upward or downward, depending on the location of the clot in its relation to the incision, may dislodge it. The constriction of the vessel above the incision is released and blood allowed to flow freely. If there is no free flow of blood, then the assumption is that there is probably another clot above the arteriotomy wound which is obstructing the circulation. An attempt should be made to dislodge it either by another incision into the vessel higher up or by aspiration through a catheter. If a thrombus is found below the point where the embolus has lodged, then an incision should be made below the point of the primary incision after having put a clamp below in order to prevent the dislodgement of the clots downward. A catheter should then be introduced into the primary incision and the segment of the vessel between the two incisions irrigated with 2 per cent. citrate solution. The incisions in the artery should not be closed before a free flow of blood has been definitely established above the obstructed point.

Proper suturing is a most important factor. The needles should be of the finest size, threaded with fine silk, thoroughly lubricated with sterile vaseline or albolene. Throughout the operation the use of 2 per cent. sodium citrate solution is suggested for sponging in order to prevent coagulation. Key emphasizes the fact that throughout his entire technic, his instruments and gloves are rinsed in the citrate solution. The curettes and probes used for removing the emboli or thrombi should be smeared with sterile vaseline.

The removal of an embolus lodged at the bifurcation of the abdominal aorta presents a much more complicated problem. The general condition is such that will not permit a transperitoneal exposure of the aorta at that point. The following method of procedure is suggested. Both femoral arteries are exposed and clamped. One artery is opened proximal to the clamp and an attempt is made to dislodge the clot by means of uterine sounds, blunt curette or by irrigation if necessary. The clamp is placed on the opposite femoral in order to arrest any fragments of the dislodged clot that may be carried into it. After the clot has been dislodged and blood flows freely, the artery may be temporarily clamped again and an arteriotomy performed proximal to the clamp on the opposite side to permit the escape of the fragments of the broken up embolus which may have come down into it. A clamp is then placed above the opening in the vessel and the incisions in both vessels closed.

The total number of embolectomies that we have been able to collect since Labey's first case is ninety-eight. This number includes the sixty-one cases reported by Key in 1922, of which ten were his own, the remaining fifty-one having been collected by him from the literature. We have made a careful search of the literature published on this subject since 1922 and we found thirty-four additional cases and three of my own, making a total of thirty-seven embolectomies performed since that time. (Chart I.)

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CHART I

Total number of cases.....	98
Reported by Key (1922)	61
Collected from literature (1922-1927).....	34
Author's cases	3
Analysis based on 37 cases, 1922-1927.	
Age	
	Male Female
Oldest	72 78
Youngest	25 27
Sex	
Male	10
Female	26
Etiology	
Cardio-vascular disease	22
Parturition	3
Post-operative	6
Not mentioned	6

The discussion of the post-operative results, the technic of the operation, and the time element as is shown in the charts is based upon an analysis of these thirty-seven cases. The operations were performed by twenty-four different surgeons, the latest case included in the series is reported from the Mayo Clinic. Operation was performed by Pemberton on October 5, 1927.

Sixteen surgeons report only one case each. Four report two cases, each, three surgeons report three cases each and one surgeon reports the largest number in the group—a series of four cases with only one recovery.

The most striking and outstanding fact gathered from the tabulation of these reports, is the continuous improvement in the operative results obtained in the last five years as compared with those in the early cases. Whereas prior to 1922, only thirteen successes could be obtained out of a series of forty-five cases, in our collected series of thirty-seven cases, there are eighteen complete recoveries. In three other cases, there was complete circulatory restoration of the part, but with subsequent death of the patient, as a result of secondary emboli that lodged in other parts of the body. In two additional cases there was partial restoration of circulation with resulting limitation of the gangrene. Death followed the operation in fourteen cases. This gives us 50 per cent. complete recoveries, 5 per cent. improvement, 8 per cent. operative recovery with subsequent death and 37 per cent. operative mortality. (Chart 2.) Most of the recoveries were obtained where the operation was performed very early. (Chart 3.)

CHART 2

Results of Embolectomy

Complete recovery	18
Complete circulatory restoration subsequent death.....	3
Partial circulatory restoration limitation of gangrene.....	2
Immediate gangrene and death	14

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CHART 3

Analysis of Results

Based on Time Element

	Time elapsed						
	Less than 4 hours	4-8 hours	8-12 hours	12-18 hours	18-24 hours	Over 24 hours	Not given
Complete recovery	4	5	2	1	3	1	2
Circulatory restoration subsequent death	1	2	0	0	0	0	0
Partial success gangrene limited	1	0	0	0	1	0	0
Deaths	4	2	2	4	0	1	1

The occurrence of emboli is more frequent in women than in men. Age is a very important factor. Most of the cases occur either in late middle life or old age. Cardio-vascular disease is given as the etiological factor in twenty-two cases, parturition and surgical operations in nine, and in six cases the causes are not given. (Chart 4.) The location of the emboli were mostly in

CHART 4

Analysis of Results

Based on Etiology

Post-operative	6 cases
Deaths	2
Complete success	3
Partial success, gangrene limited	1
Parturition complicated by cardio-renal disease	3 cases
Deaths	1
Complete success	2
Cardio-vascular disease	22 cases
Deaths	7
Complete circulatory restoration, subsequent death	3
Complete success	11
Partial success, gangrene limited	1

the lower extremities, twenty-six out of thirty-seven. The femoral artery predominated. Those in the upper extremity usually lodged either in the axillary or brachial artery. (Chart 5.)

CHART 5

Location of Embolus

Upper extremity	11
Axillary artery	5
Subclavian artery	1
Brachial artery	5
Lower extremity	26
Bifurcation of aorta	2
Femoral artery	18
Iliac artery	4
Popliteal artery	2

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It is interesting to note that no secondary emboli appeared in those cases that occurred post-operatively or following parturition. Of the nine cases falling in this category, we have five successful results, one partially successful (limitation of gangrene) and three deaths. In the twenty-two cases listed under cardio-vascular disease, we find three complete post-operative circulatory restorations with death following several days later as a result of secondary emboli.

There is one case of complete recovery following the removal of a septic embolus several days after an operation for suppurative appendicitis. (Chart 6.) This would indicate that the operation may be justified even in those who are suffering from septic diseases. The generally accepted opinion, however, is that the operation is contra-indicated under such circumstances.

CHART 6
Types of Operation Followed by Embolus

Operation	Location of embolus	Time elapsed	Result
Thyroidectomy.....	Femoral	45 min.	Death
Hysterectomy.....	Femoral	15 hours	Death
Cholecystostomy.....	Subclavian	5 hours	Success
Herniorrhaphy.....	Axillary	2½ hours	Success
Appendectomy (suppurative)....	Brachial	3½ hours	Partial success
Not given.....	Femoral	19 hours	Success

CASE REPORTS

CASE I.—R. S., female, age fifty-eight, with a history of diabetes of several years' duration. Thirty-six hours previous to admission to the hospital patient experienced a sudden pain in the forearm with numbness and tingling of her fingers. The left hand became pale and livid, and pain became progressively worse.

On admission to hospital the patient appeared quite ill, markedly emaciated, and in much pain. The right upper extremity was somewhat cyanosed but the pulse was felt. The left arm was warm, the brachial artery was palpable and pulsated to about the upper third of the arm. Below this point no pulsation was felt. At the point where the pulsation ceased, the artery seemed to be somewhat dilated. The consistency at this point was that of a hard fibrous cord. A distinct nodule could be felt apparently within the lumen of the artery. Below the elbow, the skin was of an ashen-gray color and very cold to touch. The fingers of the left hand were held in a flexed position—(claw shaped). The entire forearm was painful and motor function was impaired. A diagnosis of embolus of the left brachial artery was made and immediate operation was performed.

Under brachial plexus block anaesthesia an incision about 15 cm. long was made on the inner aspect of the left arm. The brachial artery was isolated and lifted from its bed, from the profunda brachialis down to the elbow. The embolus was easily palpated within the lumen of the vessel and could be dislodged in an upward and downward direction with ease. Two tapes were applied at points above and below the obstruction and the artery incised directly over the clot and the embolus evacuated. Blood flowed freely from the proximal portion of the vessel. The portion of the vessel below the incision was milked upward and an elongated thrombus was expressed through the incision. There seemed to be an extensive thrombosis of the vessel down to and below the bifurcation of the brachial artery. After the thrombus was expressed from the vessel,

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a ureteral catheter was passed through the incision into the vessel distally and no obstruction was met. Irrigation with citrate solution was not done for fear of driving small fragments of the thrombus into the lowermost branches of the radial and ulnar arteries. The incision in the artery was closed with vaselined silk and the soft parts closed with layer suture. The patient was in poor shape throughout the operation. I am unable to state definitely the probability of reestablishment of circulation in the arm, because the patient died suddenly six hours later with signs of cerebral embolism.

CASE II.—R. G., age seventy. Admitted to the hospital December 12, 1926. This patient had suffered from endocarditis and myocarditis for many years. With the exception of occasional respiratory difficulty, she felt well until five hours before admission when she felt a sudden sticking pain below the right shoulder radiating down to the elbow and to the finger tips. This pain became constant and increased in severity. The patient stated that the entire extremity felt numb and that she was unable to move the arm for one hour. The pain later on diminished slightly and there was a gradual return of motive power to the arm.

On admission to the hospital the right forearm, hand, and fingers appeared to be distinctly cyanosed. The extremity was definitely colder to touch than the opposite arm. No pulse was felt at the wrist, ante-cubital fossa, or along the course of the brachial artery. Some pulsation could be felt in the apex of the axilla and distinct pulsation in the supra-clavicular fossa. The patient appeared moderately shocked and complained of a great deal of pain in the affected arm with some impairment of motion. The diagnosis of axillary thrombosis was confirmed and immediate operation advised.

Under brachial plexus block anaesthesia a longitudinal incision was made over the inner surface of the upper portion of the right arm exposing the axillary space with its contents. The axillary artery was isolated but no pulsation was felt at the level of the head of the humerus. The outer border of the pectoralis major was split across in order to reach the second portion of the axillary artery, above which pulsation could be felt. The clot was located at this portion of the artery. The usual method of procedure was followed in the operative technic, and a bean-shaped clot about one-half inch in length, thick enough to completely block the vessel, was removed. The portion of the vessel distal to the incision was milked upward in order to express any portion of the thrombus which may have formed below the embolus, but none was found. When the clamp proximal to the arteriotomy was released there was a free arterial spurt synchronous with the pulse. The wound in the artery was closed with vaselined silk. After closure of the wound, a feeble pulse could be felt in the ante-cubital fossa, but no radial pulse.

The patient reacted well from the operation and the following morning the extremity was warm. Still no radial pulsation. Has dissociated sensation but full motion. Arm kept warm by electric baker.

December 8. Cyanosis disappeared. Visible improvement but no pulse at wrist.

December 10. Brachial pulse felt. Arm warm. Cyanosis entirely gone. Full motion. Sensation same.

December 13. Radial pulse felt. Circulation apparently fully restored. Patient able to raise arm at right angle to body. Normal function in hand and forearm. Wound dry and clean. Sutures removed. General condition very good.

Two days later, that is, ten days following the operation, while the patient was lying in bed, she felt a sudden coldness on the plantar surface of the right foot. This was followed immediately by a sharp pain in that area. Two hours later the pain became much worse and there was a beginning lividity of the toes, particularly the nails. Pulsation in the right femoral below Poupart's was felt, but no popliteal pulsation could be felt. There was marked tenderness over the right Hunter's canal, but no tenderness in Scarpa's triangle or popliteal space. A diagnosis of embolus of the lowermost portion of the femoral or beginning popliteal artery was made and operation performed two hours after the onset of the first sign.

Under spinal anaesthesia, an incision was made over the inner surface of the thigh

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following Hunter's canal toward the popliteal space. The lower portion of the femoral and the upper part of the popliteal artery was isolated and a large clot was removed from the upper segment of the popliteal artery. Another incision was made lower down and the segment of vessel included between the two incisions was flushed with saline solution. Both arteriotomy wounds were closed in the usual manner. Pulsations were visible after closure below the obstructed point.

The following day, the lower third of leg and foot assumed a discolored and mottled blue appearance. No pulsation or sensation. Arm wound, however, was clean and the entire upper extremity in perfect condition. On the third day dry gangrene of the leg was definite and amputation above the knee under spinal anaesthesia was performed on the fourth day. Patient died on the following day.

Dissection of the vessels from the leg showed the femoral artery and profunda femoris to be free and clear. The popliteal artery was patent and showed no evidence of any pathological changes, aside from some slight atherosclerosis. At the bifurcation of the popliteal into the anterior and posterior tibial arteries, was a saddle embolus composed of a white thrombus distal to which ran a secondary red thrombus for a few inches. Below this the arteries were empty and aside from slight atherosclerosis showed no obstruction of the lumen.

Evidently another embolus or part of the same one was overlooked at the bifurcation of the popliteal artery. In this case I should have done an arteriotomy on the anterior and posterior tibial to rule this out and possibly dislodge the clot by retrograde catheterization.

CONCLUSIONS

1. Embolectomy is assuming a definite place as a surgical therapeutic measure in cases of sudden circulatory obstruction, especially in arteries of the extremities.
2. Early diagnosis and prompt surgical measures are essential for successful results.
3. The operation should be done under regional or spinal anaesthesia.
4. Careful search should be made for obstructive emboli or thrombi above or below the primary embolus before the artery is closed.

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ILEOCAECAL ENTEROCYSTOMA PRODUCING PARTIAL INTUSSUSCEPTION *

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ENTEROCYSTOMATA of the ileocaecal valve are of interest to the surgeon because of their rarity, mode of origin, location and clinical manifestations of intestinal obstruction. Some question might arise as to whether this group of unusual tumors of the bowel should not belong to Dowd's¹ original classification of mesenteric cysts of enteric origin. Prior to the publication of his article in 1900, Hahn (1887),² Braquehaye (1892),³ as well as Moynihan (1897),⁴ omitted cysts of this type from their classification entirely. However, with Roth,⁵ Colmer,⁶ Kaufman⁷ and most others,^{8, 9, 10, 24} ascribing the origin of mesenteric cysts to faulty or incomplete involution of the omphalomesenteric duct, there should be no difference between cysts of similar structure whether they occur within the layers of the bowel wall as is seen in our case or whether they occur within the mesentery or omentum. Moynihan,⁴ in 1897, found altogether one hundred cases of mesenteric cysts in the surgical literature. Swartley,¹¹ in a recent article, states that at the present time there are two hundred cases of these cysts which have been found within the mesentery itself, and about an equal number of similar structure occurring in the omentum.

Enterocystomata are among the most uncommon of the mesenteric cysts. Colmer, in 1906, collected thirty-nine cases; four within the abdominal wall, twenty along the free convexity of the bowel, and fifteen in the mesentery. MacAuley (1924),¹² in a most comprehensive article, reviewed and abstracted twelve cases of enteric cysts occurring in the region of the ileocaecal valve. Aschner,¹⁰ in the same year, reported the abstracts of six additional cases and five more isolated cases have been collected. As might be expected, a number of these twenty-two cases are so inadequately described that there is some doubt as to whether they should be included. Still it is reasonable to assume that the same proportion of reports included in Swartley's figures are unreliable. With mesenteric cysts in general, being among the pathological rarities, enterocystomata of the ileocaecal valve as a cause of intestinal obstruction is practically unknown. This is attested by the fact that they are either omitted entirely or are scarcely mentioned in the standard surgical or pathological text-books. Although enterocystomata occur anywhere throughout the intestinal tract or remains of the omphalomesenteric duct, only those twenty-two cases reported as found in the region of the ileocaecal valve were here considered because of their similarity to the case we are reporting. No new case has been published since 1925.²⁹

* Read before the Chicago Surgical Society, December 6, 1927.

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That these cysts are of congenital origin cannot be questioned. In this group of twenty-two cases, fifteen were found either in the newborn or in infants under one year of age. The majority were discovered at autopsy.

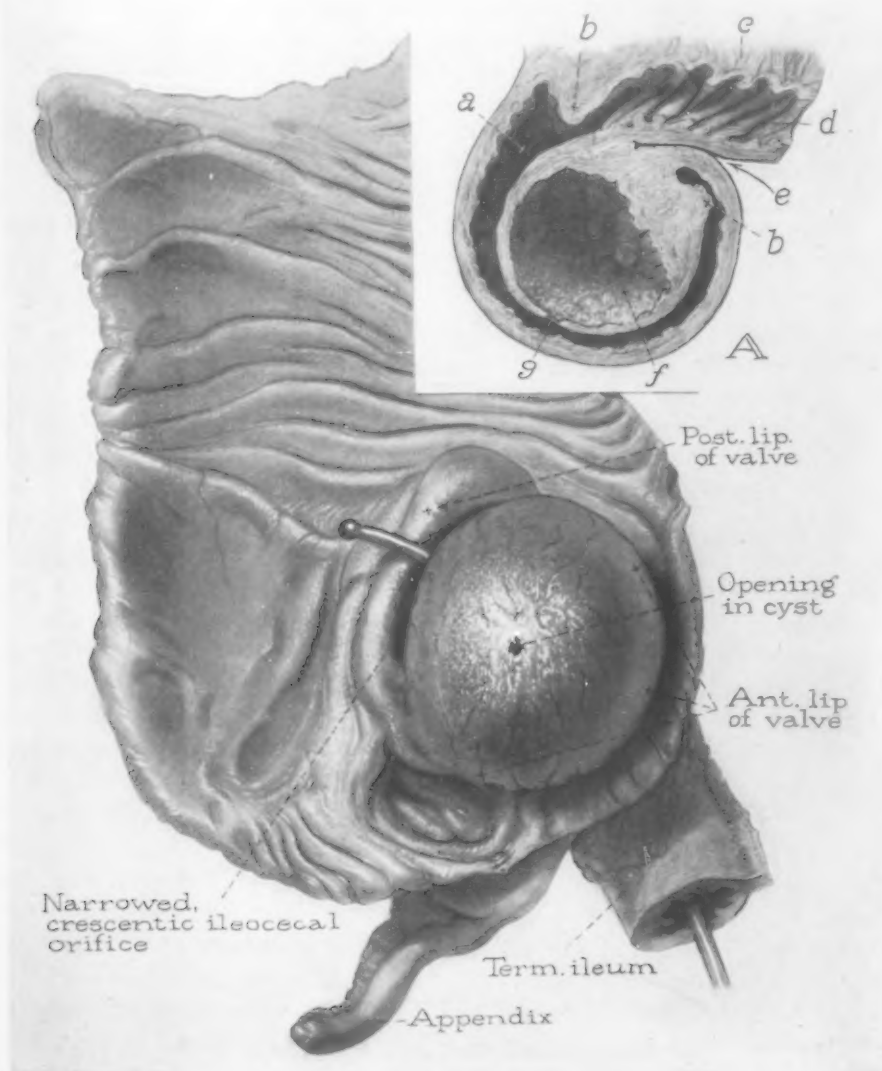


FIG. 1.—Enterocystoma of the terminal ileum protruding through the ileocæcal valve with the cæcum and ascending colon layed open. A, Cross-section horizontally through the cæcum and the ileum; *a*, cavity of the cæcum; *b*, anterior lip of the valve; *c*, mesentery of the ileum; *d*, normal ileum; *e*, peritoneal pocket formed by the partial intussusception of the ileum into the cæcum; *f*, cavity of the cyst; *g*, opening in top of the cyst.

The few cases that persisted to adult life^{18, 21, 22, 27, 28} all had recurrent symptoms of right lower quadrant disturbance. For the most part the symptoms dated back to infancy or at least for a number of years. Ayer's¹⁸ patient was twenty-three years of age and the complaints were present for seven

years. His is the oldest authentic case on record and is almost identical in every respect to our own. Our case, however, differs in that it did not have any previous symptoms. The delayed occurrence of serious trouble may have been due to the presence of a communication between the cyst and the lumen of the bowel. This permitted free drainage of the mucous secretions and thereby prevented retention and further enlargement of the cyst. The resulting accumulation of fecal material passing into the cyst eventually predisposes to infection, swelling and ultimate obstruction.

Mode of Origin.—Because of their location most authors attribute the development of enteric cysts to faulty involution or malformation of the omphalomesenteric duct. This is due to the fact that no other embryological structure had been demonstrated which could contribute to their formation. Both the faulty involution and the malformation must play important rôles if one is to consider their congenital origin and distribution. A normally placed duct with faulty involution would predetermine the location of any developmental defects. The duct has been found to connect with the ileum anywhere from four to fifty-seven centimetres from the ileocaecal valve. This makes a wide distribution of the cysts possible but it does not account for those which occur within the caecum. Baldwin,¹³ Lotheisen,²¹ and Blackader¹⁴ reported enterocystomata of the caecum occurring opposite the ileocaecal valve. Although atypical, because of the location and inability to develop from the omphalomesenteric duct, they may be included as enteric diverticular cysts of embryonic origin as originally described by Shallow.¹⁵

Other less founded and more theoretical hypotheses have been expounded to account for their formation. Sir Arthur Keith^{16, 17} found an enteric cyst in the mesentery and thought that it probably had its origin there. He states that this "shows the original site before they change their position as a result of growth expansion." Ayer¹⁸ and Turner and Tipping¹⁹ held similar views. Sequestration, inclusion, or the snaring off of portions of the embryonal gut has been held responsible for the formation of these enteric cysts by Dowd, MacAuley, Blackader, and others.^{20, 18, 21, 22, 23} All the cases of enteric cysts can now be explained on the following embryological bases as first suggested by Shallow.¹⁵

Embryological intestinal epithelium as found and reported by Keibal and Mall²⁵ is seen to contain numerous "vacuoles." "In embryos of 6.5 to 7 mm. the duodenum usually presents a well-defined round lumen, bounded by a two- or three-layer epithelium. In slightly older embryos the epithelium proliferates, and vacuoles are found within it, especially on the dorsal and right side of the tube. Later the proliferating epithelium bridges and subdivides the original lumen . . ." The lower portion of the small bowel never presents a subdivided lumen such as is found in the duodenum, but its epithelium contains scattered vacuoles, which develop in a very characteristic manner. These "vacuoles are indistinguishable from the main lumen" and occur anywhere along the intestinal tract or the omphalomesenteric duct since, early in fetal life, the entoderm of the primitive gut is continuous

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throughout the duct to the abdominal wall. Since the structure of the walls of the enteric cysts are, for the most part, exact replicas of the normal intestinal structure, this makes it significant to find such embryonal developments indistinguishable from the main lumen. As the formation of the intestinal tract develops in the fetus the vacuoles disappear. It is reasonable then to assume that these embryonal vacuoles, which are indistinguishable from the main lumen, might remain to become the anlage of the enterocysts which are of exactly similar structure to that of the adult intestinal wall.

These vacuoles occur "chiefly along the portion of the intestinal tract found within the umbilical cord, or situated along the convex surface of the intestinal coils, opposite the mesenteric attachment." This brings out the fact that there is some relationship of the enteric cysts to the omphalo-mesenteric duct and confirms the pathological findings in the cases reported. It places them on a less theoretical basis as to the malposition of the duct being completely responsible



FIG. 2.—Microphotograph of the section through the base of the cyst, showing (a) the muscularis mucosa of the lining of the cyst; (b) the mucosa with the simple tubular glands and villi; (c) submucosa; (d) mucous membrane covering cyst exactly similar to that lining the cyst; (e) longitudinal muscular layer; and (f) a plica circularis of the terminal ileum protruding with the cyst through the valve.

for the wide distribution of the cysts. In our case, as in most of the others, the cysts were found on the convex portion of the free surface of the ileum. On the other hand, the relative frequency of occurrence of these vacuoles in the duct and various parts of the intestines predetermines the probabilities of the location of the adult cyst. Therefore, with decreasing frequency, they are found along the remains of the duct, to the ileum and then ascending to the duodenum.

Multiplicity of these cysts is to be expected if one is to consider their

origin in the numerous embryonal vacuoles. Strode and Fennel,²³ in 1923, reported in a most complete description the presence of two enterocysts found in a newborn. The larger one occurred in the ileum and the other, completely separate, lying within the mesentery. Hueter's²⁶ case, although not so completely described, also had two cysts of enteric structure.

Clinically, these cysts, when occurring within the wall of the intestines, are interesting because of their mechanical interference with bowel function. Obstruction is produced either by the size of the tumor encroaching on the lumen of the bowel or as a stimulus to hyperperistalsis resulting in intussusception which most frequently occurs. Since the symptoms usually develop soon after birth, the diagnosis is almost invariably intussusception. With the picture of intestinal obstruction and a palpable mass in the right lower quadrant in an infant, the case is classical. In the few older cases, appendiceal abscess, malignancy and hyperplastic tuberculosis were considered. In no case was the true condition thought of until after thorough exploration at operation or examination of the pathological specimen was made. Eleven of the twenty-two cases of cysts of the ileocaecal valve came to operation. Five of seven resections with lateral anastomosis recovered and in two others local excision was done with uneventful recovery. Enterostomy and ileostomy were performed in the two other cases to relieve the obstruction, but the efforts were futile because of the moribund condition of the patients.

CONCLUSIONS

Enterocystomata are of the rarest type of intraperitoneal tumors.

They are congenital in origin.

They develop from embryological structures which are indistinguishable from the main lumen of the embryonic intestinal canal.

They may be multiple.

They produce intestinal obstruction.

Resection of the cyst-containing portion of the bowel or, in some instances, local excision is necessary to relieve the obstruction.

CASE HISTORY

The patient, a white male, age twenty-six, lawyer by occupation, enjoyed perfect health until two weeks prior to admission to the Presbyterian Hospital, on the service of Dr. D. B. Phemister. There had been a gradual onset of the present condition with generalized abdominal pain at first, and slight cramps which soon became severe. At the time of admission to the hospital, the attacks of cramps were associated with marked soreness, tenderness and gurgling sounds throughout the abdomen. These attacks, although distressing from the beginning, became more frequent in occurrence and of longer duration. Inaugurated by eating, especially greasy foods, moving about, or drinking cold beverages, definite relief was obtained by taking soda, milk of magnesia as a cathartic, by bowel movements induced by enemas, or with the use of an electric pad. Remissions would be only temporary. However, at the time of admission, cathartics and enemas very definitely aggravated the cramps. Bowel movements, even with stimulation, had become increasingly smaller in amount though the color and consistency remained apparently normal. No blood or tarry stools had been noticed.

For the first five days after the onset of the present condition the patient was confined to bed. Although there had been no improvement during this time, he returned

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to his office and, with the added exertion, the cramps became more severe and frequent until he found it impossible to complete his second day and was forced to return home. A physician was then called who prescribed some pills which eased him temporarily, except that the soreness and tenderness continued to increase in severity. Toward the end of the second week of the illness, the localizing complaints led to the finding of a firm movable, tender mass in the right lower quadrant. At the same time the patient had noticed that the severe cramps across the lower abdomen were associated with loud gurgling sounds. No distention of the abdomen or other unusual findings were observed. No nausea, vomiting, anorexia, or fever had been noticed.

On admission into the hospital, the patient appeared to be in good physical condition and not acutely ill. The soreness and the tenderness in the right lower quadrant were localized to a firm, egg-sized, movable mass in the upper part of the quadrant mesial to the cæcum. Slight distention with faint peristaltic waves was visible over the lower central portion of the abdomen. No increased peristaltic sounds could be detected, however, even during the height of distress. The entire large bowel was palpated as a firm cord suggesting an empty spastic condition. Fluoroscopy and plates (Fig. 3) revealed a filling defect about the size of a hen's egg, on the mesial side of the cæcum where the mass was palpated. Examination of chest, heart, and remainder of body was negative. Urine and stools were repeatedly negative (no blood, etc.). White blood-cells 8050; hæmoglobin 87 per cent.; blood-pressure 126/74.



FIG. 3.—X-ray of large bowel showing filling defect on mesial side of the cæcum.

With the above history and fluoroscopic findings the condition was thought to be very likely appendicitis with abscess formation or possibly a mucocoele of the appendix. Malignant tumor of the cæcum or enlarged lymph-glands were also considered.

Operation.—Through a right lower rectus incision the cæcum, ascending colon and the terminal ileum were delivered and examined. Because of the regional glandular enlargement, malignancy or hyperplastic tuberculosis of the cæcum was first considered. The presence of a large calcified gland made the latter more likely.

Resection of the cæcum, terminal ileum and ascending colon was decided upon. The mesentery being fairly long, a V-shaped excision with the enlarged glands included in the resection was done. Lateral anastomosis of the terminal ileum to the transverse colon followed. The post-operative convalescence was uneventful.

Pathological Report.—The specimen consists of the cæcum, ascending colon and the distal three centimetres of the ileum with the appendix and mesentery. Within the attached portion of the mesentery, there are three large, almond-sized, firm lymph-glands. One gland is yellow-gray and very hard, and on cutting, it was found to be calcified.

Externally, the anterior and mesial part of the cæcum surrounding the ileocæcal junction is markedly swollen and hyperæmic. The swelling projects and overlies the terminal ileum, forming a pocket two centimetres in depth, giving the appearance of intussusception. It cannot be reduced by traction on the ileum. Posteriorly, however, the peritoneum of the cæcum and ileum is normally flush and continuous. No adhesions are present either within the peritoneal groove or anywhere on the surface of the specimen. The appendix is of normal size and consistency and is not injected. The remainder of the specimen is entirely normal.

Within the cæcum there is palpated a firm, smooth, apricot-sized, fixed, globular mass attached to the site of the external swelling of the cæcum. The lateral wall of the cæcum is freely movable over the mass. There is no dilatation of the ileum and its walls are of normal thickness. Viewing the lumen of the cæcum through the cut end of the colon, a dark red, round tumor is seen to fill the cavity almost completely. (Fig. 1.)

The cæcum and colon are opened along the lateral margin. The lining of the bowel is normal. A globular tumor mass, four centimetres in diameter, is present on the lower and anterior part of the ileocæcal valve which is thinned out and everted by the apparent protrusion of the mass through the valve. The remainder of the ileocæcal valve is normal and uninvolved. The tumor is soft and definitely cystic. It is attached by almost its full diameter, proximal to the valve and within the terminal ileum itself. The lumen of the orifice is narrowed by the overhanging mass which gives it a very narrow crescentic shape. A free communication between the ileum and the cæcum is present when both are empty. There is a small opening, 0.3 centimetre in diameter, on the top of the cyst which leads into the cavity.

Upon opening the cyst, a large, firm, dark brown fecolith is found completely filling its cavity. Normal appearing mucous membrane lines the cyst except at the top where it is thin and flattened. The cyst wall is unusually thick at its base, measuring six millimetres. No areas of necrosis are seen. Nowhere are the layers lining the cyst continuous with those of the bowel wall.

Histology.—(Fig. 2.) Microscopic sections of the wall of the cyst shows two layers of small intestinal mucous membrane; one lining the cyst and the other covering it. Simple tubular glands which do not penetrate through the muscularis mucosa are seen in both (glands of Liebkühn). Cylindrical, foliate, or club-shaped elevations of the epithelium and tunica propria (villi) are present and at the base of the glandular depression there are numerous coarsely granular cells (cells of Paneth) characteristic of the mucous membrane of the ileum. At the junction of the cyst and the ileocæcal orifice, there is a valvula connivens with a good-sized projection composed of the entire mucous membrane and submucosa. The difference in thickness between the mucous lining and covering of the cyst is probably due to the plane in which the sections were cut.

A thick layer of longitudinal muscle is present. Bundles of circular muscle fibres are only seen at the base. Pressure atrophy must account for the slight difference in structure seen at the base and the top.

There is a thick layer of submucosa especially toward the apex. Within it there are numerous blood-vessels, lymph spaces, and lymph follicles. Marked round-cell infiltration is seen at the base of the cyst. Microscopic section of mesenteric gland.

After decalcification of the calcified gland, section shows a small area of normal lymphoid tissue. The majority of the gland is occupied by dense hyaline connective tissue, surrounding plaques of previously calcified tissue. No evidence of tubercle formation or giant-cells is present.

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SUBLINGUAL PHLEGMON

PRIMARY AND SECONDARY LUDWIG'S ANGINA

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SUBLINGUAL phlegmon is a malady of major surgical importance which is found the dominating symptom of primary or classical Ludwig's Angina. It is also seen as the outstanding feature of another group of infections about the neck which in the literature and in the clinic have been erroneously grouped with Ludwig's Angina on the strength of possessing this one symptom. The confusion that this has created has led us to set apart this latter group of cases under the name of Secondary Ludwig's Angina. The disease which has been so set apart under Ludwig's name has been defined with unmistakable clearness in Foster's Encyclopædic Medical Dictionary as "a diffuse phlegmonous inflammation of the floor of the mouth and the intermuscular and subcutaneous tissue of the submaxillary region which may end in gangrene, abscess, or resolution, and which sometimes prevails in an epidemic." The term infectious has only to be added to make this definition complete. It is a relatively uncommon disease among the great number of infections which are found occupying similar areas and presents a fairly constant and clear picture both clinically and pathologically. Yet as one scans the literature on this subject for the past few decades, it is all too evident, what a catch-all this term has been for many of the infections about the mouth and tissues of the neck, pharynx and larynx, which bear little or no resemblance to true Ludwig's Angina. The explanation is not difficult. There is among all these infections, as we have just stated, a very definite group of cases which, at some period in their course, present the cardinal symptom of true Ludwig's Angina, *i.e.*, sublingual phlegmon. One or more, or all of the other attributes of the disease described by Ludwig, may be lacking. Moreover the sublingual phlegmon itself may be from quite a different focus, of a different nature and significance from that in the classical Ludwig's Angina. A generous inclusion of these infections with that common symptom under the one head has undoubtedly been the cause of much of the confusion regarding the disease. This in turn has led to inadequate standardization of the surgical treatment and to misconceptions regarding the clinical course and prognosis. We particularly wish to deal with this atypical non-conforming group of cases—the secondary Ludwig's Anginas, and also to emphasize the need of early radical surgical treatment in all cases showing this serious and most distressing symptom.

Historical.—Among the earlier medical writers, Aretæus,¹ in his chapter

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on Angina and Quinsy, clearly describes a malady in its advanced state that modern writers have interpreted as undoubtedly the same as that which now bears Ludwig's name. He says, "Cases of cynanche are attended with inflammation of the tonsils, of the fauces, and of the whole mouth; the tongue protrudes beyond the teeth and lips; they have salivation, the phlegm running out very thick and cold; they have their faces ruddy and swollen; their eyes protuberant, wide open, and red; the drink regurgitates by the nostrils. The pain is violent but obscured by the urgency of suffocation. The chest and heart are in a state of inflammation. In certain cases there is a ready transference of the disease to the chest and these die from their metastases. . . . But if in any case there is a turn to the better, abscesses form on either side, near the ears externally, or internally about the nostrils. . . . This species is called cynanche, either from its being a common affection of those animals or from its being a customary practice for dogs to protrude the tongue even in health."

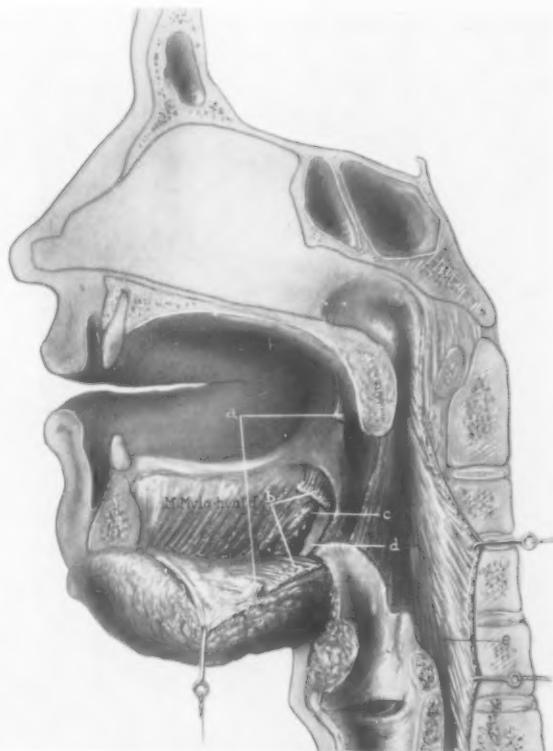


FIG. 1.—Dissection of floor of mouth and pharynx and larynx. In the dissection of a median sagittally divided head and neck, the mucous membrane of the floor of the mouth near the alveolar margin was first divided. The tongue was then turned completely over by first dividing the palatoglossus (*a*) and next the styloglossus muscles (*b*). The hyoglossus muscle was left intact. The muscles of the pharynx and lateral side of the larynx were then exposed, especially to show the close relationship of the middle constrictor (*3*) to the submaxillary gland (*c*) which curls about the posterior border of the mylohyoid muscle. The space (*d*) between the submaxillary gland and the middle constrictor muscle of the pharynx is filled with loose connective tissue.

Paulus Aegineta² in his discourse on Angina or Quinsy refers to it as a paracynanche and recognized the danger of the sublingual affection. His treatment, while inadequate, nevertheless contains certain principles of worth. "In others we must immediately bleed from the arm; and take away not a great quantity at once, but in divided quantities—should they not be immediately relieved by it we must open the veins below the tongue or make incisions in the tongue itself, if it be swollen or protrude out of the mouth."

Wells,³ in 1809, and Gregory,⁴ in 1822, each reported a case record with necropsy findings that was without doubt a "Ludwig's Angina". It

remained for D. Ludwig,⁵ however, in 1836, to describe in detail this "gangrenous induration of the neck" with completeness that has left little but emphasis to be added by succeeding writers. A year later Camerer described one of these cases and gave to it the name by which it has come down to us—Ludwig's Angina. Since this time there have been several notable contributions to the subject, particularly by Parker,⁶ Newcombe,⁷ Hamann,⁸ Thomas⁹ and others.

Nomenclature.—However inappropriate the term "Ludwig's Angina" may be considered to be and although one may object to it on the grounds of priority of description, its accorded place on the medical page of all countries for well nigh a century precludes its being readily supplanted by a descriptive anatomical term, however apt. Neither does the loose usage of the name and the widespread tendency to include under this term forms of infection failing to coincide with Ludwig's original description at once warrant its being discarded. Moreover, it scarcely seems helpful to describe under an entirely new and unfamiliar name these atypical cases whose claim, if any, to the name rests on their possession of the one cardinal symptom—sublingual phlegmon. Rather, we believe the whole subject may be clarified by a classification of these cases into a group which is to be known as Secondary Ludwig's Angina. Those which coincide with the original description may well be known as Primary Ludwig's Angina.

It may best serve our purpose to turn first to a consideration of the true or primary angina of Ludwig after which variations from it can better be understood.

Primary Ludwig's Angina.—Primary Ludwig's Angina when seen in the fully developed state is unmistakable. The features of the disease which Ludwig most emphasized and by which it is still known are:

1. A primary slight inflammation of the throat, which if present disappears in a day or so, or, if persistent may be considered as of secondary diagnostic importance.
2. A wood-like brawny condition of the connective tissue involved about the submaxillary gland.
3. A hard swelling beneath the tongue with a raised, stiff swelling of the floor of the mouth of a deep red or bluish-red color.
4. A uniform spread of the inflammation that is always sharply bordered by a zone of healthy tissue.
5. Failure of the lymph-nodes to be involved although their cellular tissue-surroundings may be affected.

Of these symptoms of primary Ludwig's Angina sublingual phlegmon is of paramount importance from the point of view of the clinician, and also to those who seek a standard of comparison whereby phlegmon having different characteristics may be compared, separated, and further classified. The sublingual phlegmon of primary Ludwig's Angina has very definite characteristics and in their absence a diagnosis cannot be made. *It is on the different immediate sites of cervical infection which may give rise to this dominating*

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symptom—sublingual phlegmon—on the different paths over which the sublingual tissues become infected, and on the different relationships which this phlegmon bears to the whole mass of infection that ample means and reason exist for dividing these cases into two groups as we have proposed.

First, all writers agree that the sublingual phlegmon in true or primary Ludwig's Angina arises primarily from the region of the submaxillary gland. Teeth, tonsils, breaks in the oral mucous membrane, etc., are the original portals of entry for bacteria. Difference of opinion exists as to just which structures next become primarily involved in the cervical tissues. Ludwig believed it was the cellular tissue about the submaxillary gland. A number of authors have considered that the submaxillary gland itself was the principal seat of the cervical infection. Roser¹⁰ held it was both. Thomas⁹ believed it to be a rapidly spreading cellulitis, beginning in the region of the submaxillary gland as a perilymphadenitis and extending to the floor of the mouth and pharynx. Davis¹¹ believes it spreads from the



FIG. 2.—Photograph of healed incision, Case XII, to show the length of wound often necessary to adequately divide the mylohyoid muscle.

original source by direct extension to neck and sublingual tissues rather than by the lymphatics. We are inclined to think that the tissues involved primarily—perilymphatic cellular tissue, loose areolar tissue, submaxillary gland or lymph-nodes—will not always be the same but will vary occasionally. Unmistakable lymph-node involvement has been observed (Case VIII). Instances of the infection being in the cellular tissues around the lymph-nodes predominate and are probably the rule. We have never observed the cervical infection to be in the submaxillary gland alone.

We believe with Thomas⁹ that the cellulitis of the submaxillary region practically always precedes the sublingual phlegmon. He collected eight reports in the literature, three of which were doubtful, where the sublingual seemed to be primary and the cervical cellulitis secondary. In all our cases

of primary angina, the cervical infection antedated that beneath the tongue. The sublingual phlegmon, however, follows more closely in the wake of the cervical infection in primary than in cases of secondary Ludwig's Angina.

Second, the path of spread to the sublingual tissues is one of extension around the posterior border of the mylohyoid muscle which makes up the muscular diaphragm of the floor of the mouth. There is usually a small lappet of salivary gland tissue to be found curling about the posterior edge of the muscle as shown in Fig. 1. A ready guide is thus afforded for the spreading cellulitis which is "decompressing" itself medially and upward by extension along the loose cellular tissue planes. Its spread is limited externally by the deep cervical fascia. Once inside the mouth it may spread with ease to the opposite side by following the horse-shoe-shaped cellular tissue arrangement about the anterior part of the tongue. Direct extension across the midline is less common but does occur.

Third, we must look upon the sublingual phlegmon of Primary Ludwig's Angina as part and parcel of a virulent process which has "decompressed" itself by extending medially when limited externally. It is no more severe a process in the sublingual region than in any other sector. Its only claim to special attention is the hazard to life it entails through extension to the larynx and embarrassment of respiration. The predisposition of this phlegmon to break down and form pus is not great but does occur and usually takes place late in the disease, as will be seen in the survey of case records.

The division of cases into a primary and secondary category need not rest alone on the characteristics of the sublingual phlegmon. A critical survey of the less conspicuous symptoms which Ludwig enumerated will also serve to cull from the general group those which strictly do not have a place among the true or primary anginas. Our observations on these lesser features of the disease picture in primary cases can do no more than bear out those set forth by Ludwig. An initial sore throat was complained of in two instances and is not usually an important symptom. The color of the tongue and the sublingual tissues becomes a deeper, more dusky blue as return venous channels are impinged upon by œdema and swelling. While it is true that actual lymph-node involvement about the submaxillary gland is not frequent, it does occur and was observed once. The general woody induration of the cervical tissues usually is present if the case is seen early but with the progress of the disease, œdema of the skin and subcutaneous tissues may obscure it to some extent.

The following are reports of eight cases of Primary Ludwig's Angina which have been in this hospital during the last four years.

CASE I.—Hospital No. 37,791.—*Typical primary Ludwig's angina—secondary to dental sepsis. Operation followed by tracheotomy. Spontaneous opening in the floor of the mouth. Recovery.*

F. S., a girl, thirteen years of age, was admitted complaining of a painful swollen area beneath the right jaw and pain in the region of the right lower first molar tooth. Four days prior to admission there appeared a swelling beneath the right mandible concomitant with an exacerbation of a toothache in the teeth of the right lower jaw.

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The swelling became more marked and so painful that it prevented sleep, rest, or taking nourishment. Two days prior to admission the floor of the mouth began to swell and the tongue was elevated to an extent sufficient to prevent closure of the teeth. On the day of admission difficulty in swallowing became quite marked. A foul discharge of thin fluid was noted to be coming from a tiny opening under the side of the tongue opposite the first molar tooth. The past history is irrelevant except for dental sepsis of long standing.

Physical Examination.—The patient presented a classical picture of Ludwig's Angina. There was a hard, tender, slightly red swelling beneath the right jaw extending from the chin nearly back to the angle of the jaw. The teeth were separated and the tip of the tongue protruded from the mouth. Saliva dribbled from the corners of the mouth. The floor of the mouth on the affected side was flush with the teeth. Pressure over the first molar tooth caused pus to exude about it. A fistulous opening was seen in the floor of the mouth opposite this tooth. Swallowing was very difficult. Temperature 101.2°, pulse 120, respiration 30, white blood-cells 30,500. An X-ray of the jaw showed an abscess of the first lower molar tooth.

Operation.—Under gas-oxygen anaesthesia an incision 6-7 cm. long was made parallel with the ramus of the jaw over the swelling. The mylohyoid muscle was opened in several places without striking free pus. All the structures were brawny and oedematous. A rubber tissue drain was inserted under the mylohyoid muscle beneath the mucous membrane of the floor of the mouth. The tooth was not extracted.

Progress.—Immediately following the operation the patient's condition improved. Some ten hours later, however, she became very cyanotic and had great difficulty in breathing. A rapid tracheotomy was done without any anaesthesia. For the next twenty-four hours a stream of oxygen had to be kept playing over the tracheotomy tube at short intervals to allay a fairly marked cyanosis. Aspiration of the trachea at intervals through the tracheotomy tube was also maintained for forty-eight hours, at which time respiration was sufficiently unimpaired to remove the tube. The patient's progress from this point on was steady, though tedious, and complicated by a sequestration of a portion of the right mandible about the abscessed tooth, a severe pansinusitis, bronchitis and otitis media. The carious teeth were removed before discharge.

Comment.—This, as will be seen in other instances, illustrates the inadequacy of spontaneous drainage of a sublingual phlegmon into the oral cavity. Removal of the secretions in the trachea by suction through the tracheotomy tube proved to be of very great aid. This procedure, we believe, should always be carried out where a tracheotomy has been done until swelling in the floor of the mouth has subsided sufficiently to allow free expectoration of secretions.

CASE II.—Hospital No. 37,251.—*Primary Ludwig's Angina following extraction of teeth in presence of dental sepsis. Operation. Recovery.*

C. E. M., a woman aged twenty-three years, entered the hospital complaining of a swelling beneath the right jaw. Three days prior to admission she had had twenty-five teeth extracted for an intractable pyorrhœa. Twenty-four hours before admission a swelling below the right jaw was noted and a little later a moderate swelling of the floor of the mouth.

Physical examination showed moderate swelling of the floor of the mouth on the right side and also a swelling beneath the right jaw, extending from the midline to near the angle of the jaw. Temperature 102.2° F., pulse 120, respiration 25.

Operation.—Under gas-oxygen anaesthesia an incision was made through the right mylohyoid muscle. A small abscess in the submaxillary gland region was encountered and drained. The posterior two-thirds of the mylohyoid muscle was divided.

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Progress.—Recovery was entirely uneventful and the patient was discharged six days after admission.

Comment.—This case affords an example of what we believe to be the rule—that the cervical infection precedes that in the sublingual space.

CASE III.—Hospital No. 37,210.—*Advanced terminal primary Ludwig's Angina. Operation. Fatality.*

E. S., a fifty-four-year-old male, entered the hospital complaining of marked swelling about the right jaw, the right side of the face, and also the left neck.

The past history is irrelevant except for a similar though much less severe swelling about the right jaw two years ago, which lasted two days and subsided spontaneously. He had had many neglected carious teeth for years.

Nine days previously he noticed a swelling about the angle of the right jaw. The swelling became progressively worse and in two days' time involved the whole side of the face and neck and had spread over to the left side. At the end of the second day he began to apply poultices and continued up to the time of admission without improvement. Speech became impeded for the last three days and swallowing became progressively more difficult from the onset of disease. He was seen by three physicians before being advised to have immediate surgical intervention.

Physical Examination.—The patient was a desperately ill adult male, who was having difficulty in swallowing and slight difficulty in breathing. The whole right side of the face and neck was swollen, red, and oedematous, from the eyebrow to the clavicle. The left side of the neck was swollen and oedematous but less than the right. The tongue was bluish, swollen and elevated nearly to the palate, and the floor of the mouth on the right side was elevated to the level of the teeth. Foul saliva dribbled from the mouth. There were several carious teeth in the right lower jaw, X-rays of which showed gross root infection. Temperature 104° F., pulse 120, respirations 30, white blood-cells, 6800.

Operation.—Under gas-oxygen anaesthesia a short incision was made under the angle of the jaw and also under the chin. Foul pus escaped from both areas. The organism was not cultured.

Progress.—The patient rapidly became worse; his pulse rose to 160–170, cyanosis came in waves and death occurred seven hours after admission. He did not apparently die of asphyxia although he continued to have difficulty in respiration.

Necropsy showed extensive brawny oedema of the neck, mouth and face. There was considerable greenish, foul pus beneath the mylohyoid muscle and in the cellular tissues of the floor of the mouth. Oedema of the larynx was present though not sufficient to cause total obstruction of the air passage. The organs of the chest and abdomen were essentially normal.

Comment.—In this instance as in many others that come to a fatal issue, the cause of death is not entirely clear. Toxaemia from the very sepsis undoubtedly plays a part; asphyxia may contribute a part. It is felt that even in cases as advanced as this, there is nothing to contra-indicate the most radical type of incisions, although, in this particular instance it probably would not have influenced the outcome. Several areas of undrained pus were encountered at autopsy.

CASE IV.—Hospital No. 32,075.—*Primary Ludwig's Angina secondary to dental sepsis. Operation. Spontaneous opening in the mouth. Recovery.*

A. B., an eight-year-old girl, was admitted to the hospital complaining of a painful tender swelling of the right side of the neck and face.

Four days prior to admission she had severe pain about a carious right lower molar tooth. The swelling in the neck began shortly afterward and progressed rapidly until

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it involved the side of the face and neck. The tongue became elevated and swollen about twenty-four hours before admission, making swallowing difficult and limited opening of the jaws.

On physical examination the child appeared to be in much pain and acutely ill. An extensive, red, oedematous, brawny, tender swelling of the tissues beneath the right mandible and about the face and neck made opening the jaws difficult. The tongue was swollen and elevated so that the floor of the mouth was level with the teeth. Temperature 101° F., pulse 120, respirations 24.

X-ray examination of the right lower jaw showed an abscess about the second molar tooth.

At operation a transverse incision was made beneath the ramus of the jaw, dividing the mylohyoid. No free pus was found at that time.

Progress.—The patient improved almost immediately following operation. On the third day post-operative, an opening in the floor of the mouth established itself and drained a moderate amount of foul pus for several days. The patient was discharged on the ninth day.

Comment.—It is impossible to say whether there might have been a small undiscovered pocket of pus present in the sublingual tissues at the time of operation. The interesting fact to be learned is that with ample incision and decompression of the cervical tissues favorable progress was made and the opening of the abscess into the mouth three days after operation had little to do with the alternate course.

CASE V.—Hospital No. 30,032.—*A typical case of Primary Ludwig's Angina of moderate severity possibly secondary to dental sepsis. Operation. Recovery.*

L. W., a woman aged twenty-four years, entered the hospital complaining of pain and swelling beneath the left jaw.

Six days prior to admission there appeared without known cause a slight redness and swelling beneath the middle of the left jaw. This steadily increased in size until the time of admission. At this time she also complained of difficulty in swallowing and inability to close the teeth completely.

Physical examination was typical of a primary Ludwig's Angina. Beneath the left jaw there was oedematous, brawny, non-fluctuating swelling, which was tender on palpation. The teeth were "poor". Swelling in the floor of the mouth made it difficult to close the teeth. There was slight difficulty in swallowing. Temperature 103.2° F., pulse 100, respiration 20, white blood-cells 19,000. The patient appeared acutely ill.

Operation.—Under novocain anæsthesia a transverse incision was made beneath the mandible. The mylohyoid was divided, exposing the deep portion of the submaxillary gland and the tissues beneath the floor of the mouth. A small pocket of pus with a pronounced sublingual oedema was found under the mylohyoid. Streptococci were recovered from a culture of the wound.

Progress was relatively uneventful except for a Vincent's Angina infection of the floor of the mouth which cleared up rapidly under local treatment. The patient was discharged from the hospital ten days after admission.

CASE VI.—Hospital No. 29,115.—*Primary bilateral Ludwig's Angina. Operation. Fatality.*

M. S., a woman twenty-three years of age, entered the hospital complaining of an acute attack of dyspnoea with difficulty in deglutition and articulation. Some six days previously she had complained of pain in the throat, had difficulty in swallowing and complained of general malaise. This progressed rapidly and in a few days swallowing became practically impossible. Shortly after onset a swelling appeared in both submaxillary regions, particularly on the left and progressed to the date of admission. On this day she had an alarming attack of acute dyspnoea.

Physical examination revealed an extensive brawny induration about both submaxillary gland areas, an elevation of the posterior part of the tongue somewhat more on the right than on the left side, and a questionable mass in the posterior part of the tongue. Temperature 103.5° F., pulse 150.

Operation.—Under gas-oxygen anaesthesia an incision was made through the mucous membrane of the mouth into the base of the tongue on the right side without striking pus. The left submaxillary region was then incised through the mylohyoid muscle and a large quantity of thick foul pus evacuated.

A culture of the wound failed to demonstrate any organism—a doubtful finding.

The patient never regained consciousness, had slight convulsions, became cyanotic and dyspnoeic. Death occurred in a few hours.

A necropsy was not obtained.

CASE VIII.—Hospital No. 21,272.—*A typical bilateral, fairly severe, Primary Ludwig's Angina secondary to peritonsillar abscess and tonsillitis. Operation. Recovery.*

L. S., a woman aged twenty-three years, was admitted complaining of swelling in the submaxillary and submental regions. One week prior to admission she had tonsillitis and a peritonsillar abscess which subsided after four days. Twenty-four hours before admission she noticed a swelling in the infra-mandibular regions and submental regions. This was followed by an elevation of the tongue sufficient to make swallowing very difficult. Opening of the jaws was limited and very painful.

Physical examination showed a hard, brawny, oedematous, tender swelling in the submental region spreading back on both sides around the submaxillary gland. The floor of the mouth was oedematous, swollen, and raised to the level of the teeth. Temperature 102° F., pulse 100.

Operation.—Under ether anaesthesia an incision was made through the geniohyoid and the anterior part of both mylohyoid muscles. A small pocket of pus beneath the middle of the tongue was evacuated. A culture of the wound demonstrated streptococci and Gram-positive bacilli.

Progress was very satisfactory. There was a temporary increase in the swelling in the floor of the mouth following the operation, which subsided rapidly, and the patient was discharged on the tenth day.

CASE VIII.—Hospital No. 17,505.—*Typical Primary Ludwig's Angina following streptococcus sore throat; involvement of lymph-nodes definite. Operation. Recovery.*

L. B., a woman aged forty years, was admitted complaining of pain in the tongue and beneath the right jaw, difficulty in deglutition, and articulation. These symptoms had been acute for two days.

This illness followed a severe streptococcus infection of the throat which began shortly after an operation two weeks previously (dilatation and curettage) for dysmenorrhoea. The infection lasted five to six days and was so severe that deglutition and articulation were well nigh impossible. Following recovery from this she felt well except for moderate tenderness over the lymph-nodes in the right submaxillary region. Twelve days after onset or two days prior to admission this tenderness increased, the right side of the tongue began to swell and deglutition again became difficult. In twenty-four hours' time the sublingual swelling had increased to such an extent that the jaws could only be moved slightly.

The physical examination centred about the local condition. There was a slight swelling in the right side of the neck below the ramus of the right jaw, extending down to the level of the larynx. A few slightly enlarged lymph-glands in the submaxillary regions could be palpated, although the whole region of the neck was extremely tender. Swelling of the floor of the mouth had proceeded to such a degree that the mouth could be opened only with great difficulty. The tongue itself was swollen, especially in the right posterior third. Temperature 104° F., pulse 96, respirations 24.

Operation under novocain anaesthesia was performed at once. The right mylohyoid

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muscle was divided and a small quantity of pus was evacuated from beneath the tongue. The organism grown was a streptococcus—type undetermined.

Progress following operation was uneventful. The difficulty in deglutition and articulation rapidly disappeared, fever subsided, and the wound granulated in well. The patient was discharged eighteen days after admission.

Secondary Ludwig's Angina.—Turning now to that group of cases of sublingual phlegmon which we have set apart under the title of Secondary Ludwig's Angina, we may consider the reasons for doing so.

First, the immediate source of focus of infection from which the sublingual tissues become involved is not in the cellular tissue around the lymph-nodes. That most usually encountered, as illustrated by Cases IX and X, is an infection or an abscess of the lymph-nodes themselves in the mental, submental, or anterior submaxillary regions in contradistinction to an infection of the cellular tissue around the lymph-nodes or in submaxillary glands as in the primary anginas. A pure cellulitis in these regions may likewise serve as a point from which re-infection may occur though this seems to be less common than abscess or lymphadenitis.

Second, the outstanding difference between primary and secondary Ludwig's Angina is the manner in which infection spreads to the floor of the mouth. The path of the secondary type is a direct one through the muscles or their median raphé instead of through the loose areolar tissue about the posterior edge of the mylohyoid muscle where a lappet of the submaxillary gland curls about it, as in the primary type of the disease. As will be seen in reports of Cases XI, XII and XIII, the area of cervical involvement is well anterior to the submaxillary gland until very late in the disease. In fact, the sublingual phlegmon antedates the spread to the tissues about this gland. Where abscesses are found to be actually burrowing through the muscles there can be no doubt as to the mode of extension.

This different mode of extension, when we consider that the muscles of the floor of the mouth constitute a much greater barrier to perforation and extension inward than does the loose cellular tissue about the submaxillary gland, readily explains why clinically the sublingual phlegmon of secondary Ludwig's Angina appears considerably later than in the primary type.

Third, the sublingual phlegmon in secondary Ludwig's Angina has in the majority of cases quite different characteristics from the infection due to the lymphadenitis or abscess from which it usually arises. It represents, as a rule, the same type of a cellulitis found about an infected lymph-node or the periphery of an abscess in any locality. Until rather late one does not find actual pus in the sublingual tissues and then it usually represents a direct burrowing through of the original abscess. Frank pus was found in the sublingual tissues in seven out of eight instances in the primary cases, compared to two out of eight in the secondary type. Leterrier's experience is similar to ours, *i.e.*, it is necessary in true Ludwig's Angina to get beneath the mylohyoid muscle before pus is encountered. This is probably to be explained by the greater virulence of the infection in the first group of cases and to ischemic tissue necrosis in a confined space.

It may be added that in our experience in secondary as in the primary type, the sublingual phlegmon never appears prior to the cervical infection even in such instances as compound fracture of the jaw with laceration of the oral mucous membrane or osteomyelitis of the jaw.

CASE IX.—Hospital No. 40,092.—*Secondary Ludwig's Angina. Extraction of teeth in presence of dental sepsis followed by submental cellulitis and later sublingual cellulitis. Operation. Recovery.*

C. A. W., a male fifty-six years of age, entered the hospital complaining of swelling beneath the chin and right mandible, and slight swelling of the floor of the mouth. For some three weeks prior to admission he had an exacerbation of infection in the teeth of the right lower jaw. About two weeks before, several teeth of the right lower jaw were extracted. Following this a swelling appeared in the submental and right submaxillary regions which progressed slowly to the date of admission. About twenty-four hours before admission the floor of the mouth began to be elevated.

On physical examination there was a tender hard swelling in the submental and anterior submaxillary regions. The floor of the mouth was moderately elevated anteriorly. Pus could be pressed from root sockets where teeth had been removed.

At operation which was performed under local anæsthesia, frank pus was encountered beneath the deep fascia in the submental and anterior submaxillary regions. The mylohyoid muscle was punctured with a hæmostat but not divided. No frank pus was encountered beneath this muscle. Convalescence was uneventful and he was discharged on the fourth day post-operative.

Comment.—This case affords a clear example of sublingual cellulitis following a submental and anterior submaxillary region abscess. There never was any evidence of extension directly from the mandible to the sublingual tissues. The submaxillary gland region was not involved. Infection no doubt spread through the muscles of the floor of the mouth.

CASE X.—Hospital No. 39,404.—*Extraction of teeth followed by submental and submaxillary region induration. Secondary abscess formation and involvement of sublingual tissues through the mylohyoid muscle. Operation. Recovery.*

G. M. R., a woman aged thirty years, was admitted complaining of a swelling beneath the chin and the right lower jaw.

Some six weeks prior to admission she had undergone an unsuccessful attempt to have a painful wisdom tooth extracted. At this time the second molar tooth was broken in the attempt. Both were removed a month later. Four days before admission a swelling appeared beneath the right jaw. This gradually increased in size over a period of five or six days before a swelling of the floor of the mouth on the affected side was noted. Operative interference was advised at once.

Physical Examination.—The patient appeared ill. The skin was hot and dry, the face flushed. Temperature 101° F., pulse 120, respirations 20. Beneath the chin and extending over toward the angle of the right jaw was a moderate swelling, tense and painful but not red or fluctuating. The right side of the floor of the mouth was elevated moderately.

Operation.—Under local anæsthesia an incision parallel to the ramus of the jaw was made dividing the mylohyoid muscle. Two small separate abscesses were found involving the mylohyoid muscle, one in the submental region and one anterior to the submaxillary gland. The pus was thin and foul. No frank pus was found in the sublingual region. A culture of the wound was sterile.

Progress was uneventful and the patient was discharged six days later.

CASE XI.—Hospital No. 31,723 R.—*Secondary Ludwig's Angina. Compound fracture of mandible in right incisor region followed by infection of submental and*

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anterior submaxillary region; secondary direct extension to the floor of the mouth. Operation. Recovery.

C. L. S., a male aged thirty, entered the hospital with a compound fracture of the mandible near the right incisor region and a severe laceration of the soft tissues about the external site of fracture. Two days later swelling developed principally about the submental region and extended to the anterior submaxillary area. This increased steadily until April 1, four days after entry. Within a few hours it rapidly extended to the sublingual tissues, raising the tongue nearly to the roof of the mouth; swallowing became difficult and respirations were slightly impaired. Temperature 102° F., pulse 90, respirations 20, white blood-cells 10,400.

Operation performed at once under local anæsthesia consisted of a transverse incision dividing the anterior two-thirds of the mylohyoid muscle which connected with vertical incisions extending from the mandible to the hyoid bone. A small pocket of thin, watery pus was found beneath the deep cervical fascia. Culture showed the organism to be *staphylococcus albus*. No frank pus was found in the indurated sublingual tissues. Convalescence was rapid and smooth.

Comment.—This case illustrates the tendency for infection in the neck to penetrate the muscles composing the floor of the mouth. Infection from the site of the fracture had extended by the lymphatics to the submental and submaxillary lymph-nodes. It was not until this was well established that the sublingual tissues were involved. There was no evidence whatever that the sublingual infection proceeded by contiguity directly from the fractured mandible to the floor of the mouth. As a matter of fact there never was any appreciable degree of infection about the site of fracture.

CASE XII.—Hospital No. 39,028.—*Secondary Ludwig's Angina secondary to abscess in submandibular region involving the floor of the mouth. Drainage of abscess followed by sublingual phlegmon. Re-operation with tracheotomy. Recovery.*

S. B., an Italian shoemaker aged twenty-eight years, entered complaining of a swelling beneath the left mandible. Seven or eight days prior to admission he noticed a small lump beneath the left mandible which was moderately painful and remained about the same size for five days. It then rapidly became larger and much more painful. For the two days before admission he experienced fairly severe pain, especially when opening the jaws and slight difficulty in swallowing. There was no difficulty in breathing.

The past history is irrelevant except for a penile chancre ten years ago followed by secondary skin lesions. He gave a history of decayed teeth for "years" but had not given them any attention.

On physical examination there was a red, tender, tense, swollen area 6-8 cm. wide beneath the left mandible. Fluctuation could not be made out. Dental sepsis and pyorrhœa about the lower incisors and canine teeth was fairly marked. There was no evidence of swelling in the floor of the mouth. Breathing and swallowing were unimpaired. Temperature 103° F., pulse 100, respiration 20, white blood-cells 11,800.

First Operation.—Under ethylene anæsthesia an incision 8 cm. was made over the swelling. About 50-60 c.c. of thick pus was evacuated from a pocket about the submaxillary gland. It had as a part of its wall the mylohyoid muscle. The posterior portion of the mylohyoid muscle was divided, inasmuch as the cavity seemed to extend forward toward the anterior end of the floor of the mouth outside of that muscle. Two rubber drainage tubes were inserted and the patient returned to the ward in good condition. A prompt regression of symptoms following the evacuation of pus was expected. The organism recovered from the wound was *staphylococcus albus*.

Progress Note.—The next morning, the patient presented an alarming picture. The floor of the mouth was flush with the teeth and the tongue elevated to the roof of the mouth. Temperature 104.2° F., pulse 110, white blood-cells 11,000. Blood culture taken

eighteen hours after the first operation failed to grow any organism. Swallowing and respiration were difficult, especially when lying down. Slight improvement followed the removal of drainage tubes and packing, and the patient was watched carefully for a few hours. Symptoms did not materially improve and twenty-four hours after the first operation a further incision was made.

Second Operation.—Under local anaesthesia an attempt was made to extend the division of the mylohyoid muscle to its anterior extremity. No pus was encountered. Lack of coöperation of the patient necessitated giving a small amount of ether, before a pocket of pus at the anterior end of the floor of the mouth could be evacuated. The sudden cessation of respiration necessitated a rapid tracheotomy and artificial respiration. Breathing was promptly resumed. The organism that was recovered at this time was a pneumococcus.

Progress.—A catheter attached to a suction apparatus was inserted through the tracheotomy tube at once and continuous aspiration maintained until the swelling of the floor of the mouth had subsided sufficiently to enable him to expectorate, a period of about five days. The amount aspirated varied from 200 to 700 c.c. per day. Examination of the chest during this period showed numerous râles at both bases with dulness and increased tactile fremitus. A flat X-ray plate revealed increased density in both lower lung fields. Temperature, pulse and respiration gradually returned to normal and he was discharged with a wound nearly healed, nineteen days after admission.

Comment.—This is a clear instance of sublingual phlegmon which arose from a localized submandibular abscess in which the mylohyoid muscle made up a part of the abscess wall. The factor which incited this quiescent abscess into a rapidly spreading phlegmon is a question though the trauma of operation doubtlessly contributed something to it. The use of the suction to aspirate the trachea was of utmost importance, especially when expectoration was impossible. It may have presented an even more grave bronchopneumonia than did occur.

CASE XIII.—Hospital No. 39,936.—*Abscess of neck secondary to dental sepsis. Definite lymph-node involvement. Part of abscess wall made up by posterior edge of mylohyoid muscle. Sublingual phlegmon part of abscess wall swelling. Operation. Recovery.*

L. C. F., a man aged twenty-seven years, was admitted complaining of a swelling beneath the right lower jaw. Past history irrelevant except for carious teeth for the past two years.

Present Illness.—Some eighteen days prior to admission the patient was forced to go home from work because of general malaise and weakness. In a few hours he had a chill lasting from fifteen to twenty minutes. The next morning his throat was very sore from a tonsillitis which lasted four or five days. At the same time that his sore throat began, the second molar tooth on the right lower jaw began to pain him and in a day or so a swelling appeared beneath the jaw. This continued to increase in size, up to the date of admission. The pain and the loss of sleep associated with it finally forced him to come to the hospital. Difficulty in swallowing began about three days previously and progressed until only fluids could be taken. On the day of admission it became a little difficult to twist the tongue about in the mouth.

Physical Examination.—The patient was an acutely ill male complaining of considerable pain in the right cervical region. There was a diffuse, red, hard, tender, oedematous swelling about the right lower jaw, extending from the face to below the larynx and from the midline to the angle of the jaw with oedema going around to the back of the neck. The jaws could be opened about one-half the normal distance. The teeth and mouth were dirty and ill cared for. Cavities in the first and third molar teeth were evidently of fairly long standing. The tongue itself appeared normal. The floor of the

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mouth on the right side posteriorly was moderately elevated. Temperature 103.3° F., pulse 96, respiration 20, white blood-cells 13,400. X-rays of the jaw failed to demonstrate any root abscesses.

Operation.—Under local anaesthesia an incision 8 cm. long was made beneath the ramus of the right jaw. In both the submental and submaxillary regions, enlarged lymph-nodes were encountered. A pocket of pus (about 25–30 c.c.) was encountered near the posterior edge of the mylohyoid muscle. Culture of this showed staphylococcus aureus. The abscess cavity extended beneath the muscle and had destroyed the posterior part of the muscle. The entire muscle was divided, allowing ready access to connective tissues of the floor of the mouth.

Progress was quite uneventful and the patient was discharged on the tenth day. After leaving the hospital a secondary abscess below the line of incision formed and discharged into the wound.

Comment.—This case is a very important link in the chain of evidence that cervical abscesses can and do invade the floor of the mouth directly. In this instance a part of the muscle had been destroyed by the abscess wall. The history of the onset is too long for a primary or true Ludwig's Angina. The relatively slight sublingual swelling was out of proportion to the great amount of swelling and oedema in the cervical tissues. The enlarged lymph-nodes encountered at operation are fairly commonly seen in secondary anginas though occasionally encountered in the primary group.

CASE XIV.—Hospital No. 39,438.—*Submental abscess secondary to impetigo on chin. Secondary involvement of sublingual tissues. Operation. Recovery.*

A. M. A., a woman aged twenty-two, was admitted complaining of a swelling in the submental region of three days' duration. Three weeks prior to admission she developed an impetigo sore on the chin which persisted in spite of various forms of treatment. Three days prior to admission there appeared a progressively increasing swelling in the submental region which was considered lymphadenitis. Shortly after admission the swelling had increased to such an extent that the movements of the tongue were a little embarrassed. Some twelve hours after admission she had an acute attack of dyspnoea. The floor of the mouth was now markedly swollen and both submaxillary regions were full, especially the left. Temperature 101.2° F., pulse 110, respiration 20, white blood-cells 10,200.

Operation performed under local anaesthesia consisted of a vertical incision extending from the chin to the hyoid bone, separating the muscles down to the floor of the mouth. A few drops of pus were obtained beneath the deep cervical fascia just to the right of the midline.

Progress.—During the next twenty-four hours all of her symptoms became much worse, i.e., difficulty in breathing and swallowing, swelling in the submaxillary region and swelling of the tongue and of the floor of the mouth. Further intervention became imperative.

At a second operation, also under local anaesthesia, incisions were carried laterally from the vertical incision to divide both geniohyoid and mylohyoid muscles. A few drops of pus were obtained beneath the muscles.

Progress.—Following this procedure the patient made a very satisfactory convalescence. The oedema in the mouth and neck began to subside in about twenty-four hours. She was discharged on the fourteenth day.

Comment.—This case adds another valuable bit of evidence regarding the mode of extension of infection through the mylohyoid muscles. At the first operation the pus was encountered beneath the cervical fascia. At the second it was found beneath the muscles of the floor of the mouth. The

submaxillary gland regions were only involved secondarily by spreading cervical cellulitis. Anatomically there is no evidence whatever that the lymphatic drainage from the mental region where this infection originally started is into the floor of the mouth. Rather, as Sappy points out, the mental region drains into the submental and submaxillary lymph-glands. The path of infection certainly did not lead to the submaxillary salivary gland region and thence to the floor of the mouth as in a true or primary Ludwig's Angina.

CASE XV.—Hospital No. 36,909.—*Dental sepsis with recurrent attacks of submaxillary indurations, the last of which was associated with sublingual phlegmon and abscess formation. Spontaneous inadequate drainage into the oral cavity. Operation. Recovery.*

W. I. H., age fifty-three years, a farmer, entered the hospital on September 20, 1926, complaining of carious teeth and a recurrent swelling beneath the right jaw, also swelling of the floor of the mouth.

Some three months prior to admission the patient had the first of a series of four recurrent "lumps" beneath the right jaw. Each lasted about a week, was associated by moderate dysphagia, fever, malaise and weakness sufficient to confine him to bed. During the third attack an X-ray examination of the teeth of the right lower jaw was made which demonstrated several apical abscesses.

The present attack began about five days ago with fairly painless swelling beneath the right jaw. The swelling increased and at the end of three days it had extended from the chin to the angle of the jaw. Pain became fairly acute. On the fourth day the floor of the mouth began to swell and deglutition and speech became impaired. On the day of admission the pain was severe, the tongue lifted into the roof of the mouth and dysphagia was fairly marked. Saliva dribbled from the mouth. X-ray examination of the jaw again revealed inflammatory reaction about the roots of the molar teeth of the right lower jaw. Temperature 99.2° F., pulse 110, respirations 22, white blood-cells 13,500. The family history and past history are irrelevant except for carious teeth for "years".

Physical Examination.—The patient was a large, rugged, somewhat obese adult male with a short fat neck and a double chin. Beneath the right jaw was an extensive swelling extending from the angle of the jaw forward to beyond the midline. There was moderate œdema of the skin but no redness and but little tenderness on pressure. The tongue was dry, brownish, parched, and elevated nearly to the roof of the mouth. The right side of the floor of the mouth was about even with the teeth. Swallowing was moderately difficult.

First Operation.—Under novocain anæsthesia, the skin and subcutaneous tissues were divided down to the mylohyoid without striking pus. All the tissues were œdematous and brawny. Gas-oxygen anæsthesia was then given in order to divide the posterior part of the mylohyoid muscle. No pus was found. A loose acriflavin gauze drain was inserted into the wound. The organism recovered from the wound was staphylococcus albus.

The patient's condition did not improve and eighteen hours later a small incision under local anæsthesia was made in the floor of the mouth on the right side, where the swelling was the greatest. No pus was found. A few moments later a small amount of pus was spat up. The source could not be ascertained. Temperature 102° F., pulse 100, respirations 28.

No improvement followed this and twenty-four hours later the neck was re-explored under local and gas-oxygen anæsthesia. The incision was carried backward until the whole submaxillary gland was exposed without finding anything except brawny œdema. The incision was then carried forward and after dividing the mylohyoid and geniohyoid

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muscles, a small pocket of foul pus was encountered in the midline beneath the anterior part of the tongue.

Fairly prompt convalescence followed the drainage of this pocket. The swelling in the tongue and the floor of the mouth receded rapidly. Deglutition and respiration improved promptly.

Comment.—It is difficult to see how the sublingual phlegmon arose in this instance unless by direct extension through the floor of the mouth. The submaxillary induration was in all the attacks the usual type of lymph-gland infection deep to the cervical fascia. In the last and most severe attack the process spread by direct contiguity through the floor of the mouth muscles into the sublingual tissues. There seems no need to presume that the submaxillary gland or its capsular tissues were the focus from which infection was relayed to the sublingual tissues. In fact, at operation the submaxillary gland region was not particularly involved. Neither need one presume a retrograde lymphatic infection from the submaxillary gland region to the anterior part of the floor of the mouth where the infection was most severe and the abscess found.

CASE XVI.—Hospital No. 16,569.—*Abscess of submaxillary region beneath deep fascia with secondary involvement of cellular tissues of the floor of the mouth. Operation. Recovery.*

F. W., a woman twenty-three years of age, was admitted to the hospital complaining of difficulty in swallowing and swelling of the right side of the neck.

Five days previously she had a carious tooth extracted from the right lower jaw. Two days after this a swelling appeared about the right lower jaw and with its continued increase in size, difficulty and pain on swallowing became fairly marked.

On physical examination there was found a hard, regular smooth swelling beneath the right lower jaw extending over to the midline. The floor of the mouth was moderately swollen. The first and third right molar teeth were missing. Temperature 99.6° F., pulse 110, white blood-cells 23,000.

Operation consisted of an incision through the deep cervical fascia on the right side. Free pus was found and the pocket drained; the mylohyoid muscle was not divided. A culture of the wound showed the organism to be a streptococcus.

Progress was uneventful. The patient was discharged on the ninth day with the swelling nearly gone.

Comment.—This would seem to be an undoubted instance of sublingual phlegmon secondary to a pocket of frank pus beneath the deep cervical fascia. The record unfortunately does not indicate whether the mylohyoid muscle was part of the abscess wall or not. No mention made of involvement of the submaxillary gland. In neither of the two preceding cases was the process in the sublingual tissues of the same character as that in the neck. This differs from primary Ludwig's Angina when the two are usually identical. In this case the sublingual process was a pure phlegmon with a cervical abscess while the reverse was true in the preceding case.

Etiology.—Newcombe,⁷ commenting on true Ludwig's Angina, says that "the true way to look upon the disease is to regard it first as an intensely infectious phlegmon, and second, as occurring under peculiar anatomical conditions." This is even more true of sublingual phlegmon alone. Streptococci are commonly the infecting organism in the primary type of the disease

and staphylococci predominate in the secondary type. While bacteriological studies have been routinely made, they have not been sufficiently detailed in our cases to warrant any new conclusions. A sterile culture from a wound in such an infection is to be looked upon with suspicion. Smears of the fluid or pus stained by Fontana's method would probably show spirochaetes to be the infecting organism. Ordinary bacteriological studies fail to grow these organisms.

Predisposing causes and original sources of infection are the same in the two groups of cases. Hamann,⁸ in 1894, called attention to the major rôle that dental sepsis plays in such infections. Compound fractures of the lower jaw, impetigo of the face, wounds of the floor of the mouth, tonsillitis, scarlatina and diphtheritic infections all have been mentioned in a few instances as the etiological factor. The early impressions that sublingual phlegmon was a disease "*sui generis*" probably arose from an occasional observation of this type of infection in healthy robust individuals in whom none of these predisposing causes could be demonstrated.

The age incidence is practically the same in both groups of cases and is greatest between the years of twenty and thirty. The youngest patient was eight and the oldest fifty-six.

In our series the incidence is greater in females. In the primary anginas there were seven females and one male. In the secondary anginas three females and five males. This ratio is quite the reverse of that given in the literature for true Ludwig's Angina where males predominate.

Clinical Course.—Primary Ludwig's Angina begins and continues to its termination as a fulminating rapidly spreading cellulitis. The onset may be that of pain from carious teeth or a transitory tonsillitis. This is quickly obscured by the pain in the submaxillary gland region due to distention of tissues. Tension on the cervical tissues is usually great enough by the third day or fourth to force an extension to the sublingual spaces. Here the process of sublingual phlegmon may continue for three to four more days before definitely invading the larynx in the manner to be described. The time in which a typical untreated case may come to a fatal issue is from nine to twelve days. The actual symptoms of involvement of the sublingual and laryngeal tissues are too well known to redescribe except to point out the very great suddenness with which laryngeal obstruction may come on. That death may supervene in a few moments in subjects who have apparently no respiratory distress has been attested by a number of writers.

As one might surmise from the pathological anatomy of secondary Ludwig's Angina, the symptoms are naturally less fulminating. It is common to obtain a history of cervical, submental or intra-oral sepsis for a week or ten days before there are any sublingual symptoms. In Case XIV there had been recurrent attacks of cervical lymphadenitis for months before the final attack. Symptoms are less severe. Laryngeal involvement is a much later manifestation than in the primary type of the disease and occurs much less frequently. The mode of invasion of the larynx is nevertheless the same.

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Invasion of the Larynx.—Obstructive laryngeal symptoms are a fairly late manifestation of the disease and naturally vary with the rapidity with which the infection spreads. It is no doubt true that with wider recognition of the nature of the malady fewer cases go on to a critical stage of respiratory embarrassment than in Ludwig's time or even twenty years ago when Thomas' excellent study of this condition was published.

The path by which infection spreads from this space into the larynx is, as Thomas suggested, a postero-lateral one. There is a hiatus between the posterior edge of the mylohyoid muscle and the middle constrictor muscle of the pharynx filled with loose areolar tissue. In the lower part of this space are to be found the tendon of the stylohyoid muscle and the glossopharyngeal nerve. Both course along the side of the larynx and may easily serve as a ready guide to a spreading cellulitis.

In an attempt to determine if this pathway for infection could be demonstrated experimentally, we injected under force a thick watery barium suspension into the sublingual tissues in four fresh autopsy specimens. In each of these the barium could be traced into two locations—first, about the sublingual salivary gland and out into the tissues of the submaxillary region, and secondly, and quite distinctly, into the tissues at the side of the epiglottis and larynx. The amount naturally was small but nevertheless unmistakable. Likewise the path by which it reached the larynx was in accord with that mentioned above, *i.e.*, through the space between the middle constrictor muscle and the mylohyoid muscle.

Treatment.—Early radical surgical intervention cannot be too strongly urged. The fundamental principal of operation for sublingual phlegmon and consequently for both types of the disease is primarily to relieve tension and secondarily to relieve pus. For this reason short incisions have little if any place. When the sublingual tissues have become tense and indurated, as Leterrier¹² and Niedermeyer^{13, 14} in particular have pointed out, an incision should be made to divide the mylohyoid and possibly the geniohyoid muscle on the affected side. By beginning in the region of the submaxillary gland and keeping close to the ramus of the mandible as the incision is carried forward, no structures of importance are encountered except the facial artery. A word of caution may not be amiss in regard to dividing this. It is apt to be stretched outward like a bow string by the underlying swelling, and if divided before being secured may retract well into the cedematous tissue, giving troublesome bleeding.

Where the principal part of the cervical infection is submental or anterior to the submaxillary region a T-shaped incision is very useful, the shorter limb of the incision being from the mandible to the hyoid bone. As mentioned above, short incisions one to two inches long are theoretically unsound and usually prove inadequate and temporizing. Intra-oral incisions fail to give the decompression for the tension in the sublingual tissues and are impossible to keep clean and aseptic. Such incisions, made for cosmetic reasons only, as suggested by Jacques,¹⁵ have no place in so serious a malady. Spon-

taneous opening of a small abscess in the floor of the mouth in either primary or secondary Ludwig's Angina rarely affords sufficient drainage or relief of the tension on the tissues and an adequate external incision should be made without delay even in the presence of spontaneous intra-oral drainage. Removal of the submaxillary gland suggested by Rehn¹⁶ is unnecessary if the mylohyoid muscle is adequately divided and the capsule of the gland incised when this is necessary. It has been our own plan to go as far as possible with local anæsthesia—blocking off the cervical nerves posterior to the sterno-mastoid muscle—and if necessary to administer a short nitrous oxide oxygen anæsthesia to complete the incision.

A tracheotomy set should be a part of the armamentarium in any case where there has been any laryngeal symptoms at all. As mentioned under the comment on Case XIII, suction of the tracheal secretions through a small catheter in the tracheotomy tube may be a life-saving measure. It should be practically continuous until subsidence of the swelling beneath the tongue will again permit expectoration.

Mortality.—The mortality is reduced in proportion to the promptness and thoroughness with which the sublingual tissues are "decompressed" and relieved of tension and any pockets of pus evacuated. Among 106 collected by Thomas up to 1908 the mortality was 40 per cent. We have collected 92 cases appearing in the literature since that date which seemed to be authentic. The mortality in this group was 31 per cent. Among our own cases there was a mortality of 25 per cent. (two out of eight cases) among the primary Ludwig's Angina with no fatalities among the secondary type which makes a combined mortality of $12\frac{1}{2}$ per cent. The difference in the two groups doubtlessly represents the relative frequency with which the larynx is involved. The cause of death is not certain in all instances. Toxicity from the marked sepsis undoubtedly has a great deal to do with it. Partial asphyxia may also contribute. Only occasionally does a sudden total occlusion of the larynx by œdema of the glottis cause death.

SUMMARY AND CONCLUSIONS

1. Sublingual phlegmon is a malady of major surgical importance which is found as the dominating symptom of primary or classical Ludwig's Angina. It is also seen as the outstanding feature of another group of infections about the neck which in the literature and the clinic have been erroneously coupled with primary Ludwig's Angina on the strength of this one symptom.
2. The confusion this has created has led us to set these latter cases apart under the name of secondary Ludwig's Angina.
3. Secondary Ludwig's Angina differs from the primary or classical type of this disease, in that (a) the sublingual phlegmon is secondary to lymph-gland infection and cervical abscess rather than to an infection of the cellular tissues about the lymph-glands or submaxillary salivary gland; (b) the sublingual tissues are infected by a direct extension through the muscles which make up the floor of the mouth. Extension is through the

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loose areolar tissue about the submaxillary gland as it curls about the posterior border of the mylohyoid muscle; and (c) the sublingual phlegmon is to be looked upon as the peripheral manifestation of a cervical abscess or lymph-gland infection and not as an integral part of an original fulminating cellulitis as in primary Ludwig's Angina.

4. The formation of pus in the sublingual tissues is the rule in primary Ludwig's Angina and rare in the secondary type of the disease. Streptococci predominate in the former group and staphylococci in the latter.

5. Extension to the larynx occurs much more frequently in primary Ludwig's Angina. The phlegmon finds its way to the side of the larynx and epiglottis by extending through the aperture between the posterior edge of the mylohyoid muscle and the middle constrictor of the pharynx.

6. The theory on which the successful treatment of both types of the disease is based is primarily to relieve tension or to "decompress" the sublingual tissues and secondarily to evacuate pus which may extend well into the muscles of the tongue. A long, free, external incision dividing the mylohyoid muscle is essential.

7. The mortality of the disease in 104 cases collected by Thomas in 1908 was 40 per cent. In 92 cases we have collected since that date the mortality has been 31 per cent. In primary Ludwig's Angina our mortality has been 25 per cent. In secondary Ludwig's Angina there have been no fatalities.

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ULCERATIVE COLITIS *

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ULCERATIVE colitis was first described as a pathological lesion by Wilks and Moxon in Lectures on Pathological Anatomy in 1875. Thirteen years later, or in 1888, appeared apparently the first clinical description by Sir William Hale White. From this time on little was written on the disease for many years. While separation into amœbic and bacillary types was definite, there remained a large number of cases of the so-called non-specific type, which were the cause of much worry and apparently fruitless study. In 1909, in a symposium on the non-specific type held by the Royal Society of Medicine in London, the cases were reported by the various hospitals; St. George's, 19 patients, 9 died, 10 relieved; 4 operations, 3 improved, 1 died; St. Mary's, 19 patients, 15 per cent. mortality; St. Thomas', 80 patients, 40 died, 15 operations, 8 late of whom all died, 7 earlier, 1 died; Westminster, 42 patients, 19 died. In a discussion of the disease before the same society in 1923, Sir Humphrey Rolleston summarized the situation admirably in a statement that ulcerative colitis was not a disease in the strict sense of the word any more than rhinitis or bronchitis but was a syndrome with fairly constant clinical manifestations and anatomic changes which may be excited by different factors with the probability that the ulcerative process originally due to one microorganism may be kept up by the combined attack of different bacteria or to successive strains of pyogenic bacteria. Mr. P. Lockhart-Mummery in a similar discussion noted the commonly fatal consequences of the disease and the small advances that had been made in the diagnosis and treatment in recent years. This latter statement was based more particularly on the failure of elucidation from the point of view of bacteriological investigation and likewise the failure of medical treatment to give relief except in the mild cases. In 1924, however, there appeared in the Collected Papers of the Mayo Clinic the work of J. Arnold Bagen. In this he submits for the first time the finding in repeated cases of ulcerative colitis of a Gram-positive diplococcus "plump, with a tendency to be lancet-shaped—about the size of pneumococci—no capsules, little tendency to grow in chains, and on blood agar plates forming colonies resembling the alpha-hemolytic streptococcus." With pure broth cultures of some strains of those streptococcal types recovered from the ulcers of chronic colitis cases, intravenous injections into rabbits and dogs have produced, in a high percentage of cases, lesions essentially like those in human beings. Moreover the diplococcus has been reisolated from the heart's blood and mesenteric lymph-nodes of animals dying from the disease and these cultures have produced similar

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lesions when reinjected into other animals. While this experimental work is not final in the determination of the cause of all cases of this disease, it is a most important step toward establishing a specific cause for a large number of cases. Prior to this, the etiologic factors were numerous and uncertain, each had its advocates among men of experience in handling the disease. Logan and his co-workers assumed metabolic disturbance to be the underlying cause, many workers considered the amœbæ or dysentery bacilli to be the original invaders and the ulcerative colitis to be due to secondary infection. The German workers and Bassler considered increased virulence of the colon bacillus to be of paramount importance. Rolleston, Lockhart-Mummery, Brown and Yeomans emphasized the importance of the streptococci. The uncertainty of etiology as shown above has been well reflected in the terminology of the disease ulcerative colitis—non-specific, infectious, post bacillary, septic, idiopathic.

During the past year we received on the Cornell Surgical Division at Bellevue Hospital four cases of this disease which proved to be of such surgical interest that they led me to review the seventeen cases we have had on the Surgical Service and the sixty-four diagnosed similarly on the combined Medical and Surgical Service. This review was made, naturally, with the idea of ascertaining what surgical treatment was best indicated in these cases and when such intervention should be made, and like every such review brought to my attention certain facts and findings that I hope may prove of interest to this society.

Ulcerative colitis is an inflammatory disease of the colon, probably infectious, characterized by an extremely varied clinical and pathological course, from the mildest grade of inflammation of the mucosa to the most profound type of phlegmonous infiltration which may end speedily in peritonitis or perforation and death. Fortunately it usually assumes the milder forms, probably due to the specific bacterial factor, and tends toward chronicity or at times toward remissions. Such remissions may be of long duration only to be interrupted by a sharp exacerbation which may in turn equal or surpass the previous attack in severity and which strongly suggests in these cases a consideration of the colon as a sensitized area of infection, reawakened by either a "bacterial shower" from some distant focus, or lighting up in a patient of lowered resistance. In incidence, men are more prone to show the disease than women and in men the years between twenty and forty show more cases than the decades above or below, although no age seems completely immune. Foci of infection such as teeth, tonsils, respiratory tract, gall-bladder, etc., are given as significant findings in a strikingly large number of the cases, either by the history of onset or as physical findings with the disease itself.

Bacteriologically little has been done specifically on the disease until the work of Bargen. This work is illuminating and stimulating. In our last three cases we were fortunate enough to have the coöperation of Doctors Torrey and Kahn of the Cornell Department of Hygiene in working on the

bacteriology. One case looked like a Bargen's diplococcus, one showed a streptococcus growing best under anaërobic conditions, one was reported non-committally. These were after repeated cultures from the bases of ulcers, specially cultured, virulence tested as to the colon bacilli and conservatively reported. Oddly enough the third case is the only case in our series apparently helped by emetin although no amœbæ were ever found. Other cases have been searched for amœbæ and acid fast bacilli and emetin tested without result. Interesting in this connection is the observation of Lockhart-Mumery that some of the worst cases are secondary to amœbic or bacillary dysentery and the report of a striking result in one case of Crohn's by two injections of polyvalent antidysenteric serum, but whether the result was due to the serum therapy or the protein shock therapy is left open to individual opinion.

Symptomatically the disease presents a fairly familiar picture characterized by diarrhoea of varying intensity from four to even twenty or more stools a day, frequently accompanied by tenesmus or mild colicky pains depending on the severity of the lesions in the rectum or in the colon above the rectum. The stools contain blood or pus in varying amounts. Fever usually accompanies the condition and varies from a nightly rise of one or two degrees to the almost typhoidal type of temperature in the severe acute cases. Prostration, loss of weight and anemia are progressive and this anemia (from 30 to 75 per cent. in these cases) seems dependent not only on the blood lost in the rectal discharges but on the sepsis of the disease itself. Leucocytosis may or may not be present and in our cases has not been a helpful criterion—varying from 3600 to 13,600. No polynucleosis above 80 per cent. has been seen in these cases even in those with marked peritonitic signs, and oftener than otherwise the polynuclear leucocytes have ranged below 70 per cent. Physical findings correspond to the duration and severity of the symptoms as to evidences of anemia, dehydration, etc. The abdomen in the cases seen by the surgeon, however, may show a thickened rolling tender colon, either local in the left lower quadrant or diffuse if the disease is extensive, with at times a picture of localized tenderness and rigidity so marked (as in two of our cases), that peritonitic irritation is obvious and perforation or diverticulitis may be suspected.

Sigmoidoscopic examination will establish the diagnosis in practically all of the cases. In a case with twenty or more bloody stools a day and violent rectal tenesmus, such examination may not be easy. Careful manipulation, without force, to avoid possible perforation and preferably under the guidance of the eye as aptly suggested by Crohn, should bring out the diagnosis. The rectum and colon are the seat of an inflammation in which the mucosa is first red and congested with increased watery secretion. It bleeds from a velvety or granular surface on the slightest trauma and fades into normal mucous membrane if any such can be seen. Edema and thickening quickly follow and shortly miliary abscesses appear in the mucosa. With rupture of these, small punched out, bleeding ulcers may be seen or with coalescence of these,

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large diffuse ulcers with undermined irregular edges may form and progress more or less deeply into the wall of the gut. Remission with scarring at the base of the smaller ulcers may give rise to the pitted "pock-marked" glazed mucosal surface which is considered by Buie to be pathognomonic of a previous attack or exacerbation of the disease. In the older cases areas of scarred mucosa may show intervening folds of granular inflamed mucosa that strongly suggest polypoid outgrowths from the colonic wall. A similar appearance is sometimes seen in the earlier cases but here seems to be due to the areas of normal mucous membrane jutting out into the lumen of the gut between the surrounding ulcerated areas. The difference between ulcerative colitis and other forms of recurring diarrhoea should be cleared up by the sigmoidoscopic picture.

Pathologically the degree of inflammation may vary most markedly—from the milder superficial inflammation confined mostly to mucosa and submucosa to the very profound phlegmonous type which involves the entire wall of the gut even to peritonitis or perforation. Congestion, œdema, polynuclear infiltration, round cell infiltration will all show in the various layers of the wall of the gut to a degree dependent upon the acuteness of the inflammation. Grossly, as in one case shown here to-night, the colon may be tremendously thickened with the exudative process so that even on compression between the fingers the two succulent friable walls may total a thickness of one to one and one-half inches. The lumen may seem to be practically obliterated. The serosa may be involved to the point of fibrinous exudate and fresh adhesions to the overlying loops of small intestine or even to the parietal peritoneum may be found. As might be expected, œdema and thickening of the mesocolon with enlargement of the lymph-nodes may be present. In the more subacute or chronic forms, however, where round cell infiltration and fibrosis occur in the deeper layers added to the more or less deep ulceration of the mucous membrane, the colon may become a thick walled rope-like tube with œdematous walls, without sacculations, in which a lumen is hard to imagine. Later contraction of the fibrous tissue may lead to narrowing of the lumen which may be permanent and if localized may result in partial bowel obstruction. That complete resolution may occur in the acute cases must be acknowledged. On the other hand, that fatty degeneration of the liver and heart may occur in the cases of long duration must also be acknowledged (due, probably, to the long continued anemia). The possible sequelæ in the subacute and chronic cases are interesting for hypothesis. Polyposis and malignancy are recognized as occurring. Knowing the nature of the pathological lesion and the fact that the disease seems to practically always start about the rectum and extend up the colon, is it not also fair to assume that benign annular stricture of the colon and long tubular strictures of the rectum and sigmoid may be logical sequelæ of the same disease? It seems to me in retrospect that I have had four cases so explained and personally it is my opinion that the disease ulcerative colitis or proctitis is the causative

factor in many of the tubular strictures of the rectum and colon which have been considered luetic (without proof) or idiopathic.

In diagnosis the Röntgen-ray may confirm or elucidate the differential picture. Interference with peristaltic waves so that they are lengthened and more superficial, absence of haustral markings, narrowing due to fibrosis with perhaps eventually stenosis are the essential findings. Local spasmodic stricture will show in some of the acutely inflamed cases. In some of the older cases large areas of ulceration may be brought out in the X-ray film after evacuation of the barium enema from the colon and the immediate light distention of this organ by pumping air into it.

Differential diagnosis with the above aids should separate ulcerative colitis from the ordinary diarrhœas. The X-ray and sigmoidoscope should also establish the diagnosis between a tuberculous infection of the colon and ulcerative colitis, although the clinical symptoms and physical signs on examination frequently simulate a tuberculous infection. Diverticulitis, malignancy and benign stenosis or stricture may have to be determined.

Treatment.—In discussing the treatment of a condition so diverse in its relative intensity and manifestations as is ulcerative colitis, it must be obvious at once that the vast majority of these cases will fall first in the hands of the internist. In reviewing the literature on the subject it is equally obvious from the diversity of opinion as to diet, medication and multitude of solutions used for enemata and irrigations that such treatment by the internist has been unsatisfactory alike to both patient and physician in a large percentage of patients, not only because of the poor response of many cases to even the most carefully outlined treatment but also because of the mortality attending such treatment. In the hands of most competent men such mortality is not without significance as is shown in the reports of various series of cases. (Logan 7.5 per cent.; Lynch and Felson 12.2 per cent.; Albu 14.2 per cent.; Crohn and Rosenberg 6.6 per cent.; Yeoman 5.5 per cent.). However, in this paper no attempt will be made to repeat any outline of medical treatment as such is well covered in the literature. The greatest encouragement medically in recent years seems to have come with the introduction of the dyes, such as acriflavin and gentian violet, for irrigation purposes and the local treatment of such lesions as may be reached through the proctoscope or the sigmoidoscope. In addition to such treatment elimination of possible initiating foci of infection and the use of either a vaccine or vaccine filtrate in such cases as show the Bagen diplococcus may also be instituted.

While these methods may cure or alleviate the mild acute or chronic cases, there will remain a fairly large number of the very acute cases or chronic cases with acute exacerbations in whom surgery must be considered. And if this cellulitis of the colon with redness, œdema, swelling and multiple ulcerations and bleeding points were on the body surface in plain sight, I have the feeling that surgical measures would be much more frequently and much more promptly considered. In 1902, Weir is credited with the first appendicostomy performed for ulcerative colitis although the operation had been

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suggested for irrigation purposes by Keetley as far back as 1895. This operation has theoretical advantages but such practical disadvantages that it has become largely obsolete. In 1900, Bolton performed the first valvular cæcostomy, followed in 1901 by Markoe and Gibson whose idea it was. Somewhat later the first transverse ileostomy is credited to Dr. John Brown of St. Louis and has since been done both alone and in combination with appendicostomy for irrigation purposes. Justifying the choice of the surgical procedure on an understanding of the pathology of the involved colon, it is logical to choose such a procedure as will provide first, rest to the involved colon; second, opportunity for irrigation; third, opportunity for closure without undue hazard after restitution of the gut to normal or nearly normal has been completed. Without holding a brief for cæcostomy, it does seem to me that this operation fulfills these three essential purposes more satisfactorily than either appendicostomy or ileostomy. Appendicostomy alone has had its vogue. It still has some supporters, but as an operation for any but the mildest type of ulcerative colitis, it provides no exit for the colonic contents and likewise provides very unsatisfactory entrance for irrigation solutions. Ileostomy gives rest to the involved colon most adequately. Combining it with appendicostomy or cæcostomy or even leaving the distal loop open may provide the means for irrigation. Closure of the gut by ileocolostomy at whatever site chosen becomes a fairly formidable operation as a secondary procedure and is certainly not without hazard. Theoretical disadvantages of anastomosis to the lower sigmoid may possibly occur from the blind loop of colon left and the possible inability of the rectum and lower sigmoid to concentrate the stools.

Cæcostomy done as a liberal opening into the gut (and by this I mean one to one and one-half inches) may be effected through a McBurney incision with attachment of the gut to the peritoneum and parietes at the bottom of the wound without much difficulty. The opening into the gut may be delayed until sufficient adhesion to prevent soiling of the peritoneum has occurred. By this measure adequate drainage is supplied to give the colon surgical rest, opportunity for easy irrigation is provided and after such cæcostomy has served its purpose, which may take from a few weeks to three or four months, closure of the shrunken direct cæcal fistula can be accomplished as a rule without a formidable operative procedure. In describing this type of simple cæcostomy, I have gone into detail purely to differentiate this type from the valvular type of Gibson or Senn, which seems to me to have no place in the treatment of this condition unless used as an adjunct to ileostomy. Theoretically both cæcostomy and ileostomy have been opposed on the grounds that such short circuiting operations may enhance the possibility of diffuse stenosis of the colon. While benign local stricture is not infrequent, complete obliteration or stenosis is very rare and I find only two such cases mentioned in the literature. The last case so reported by Eichenwald in the *Archiv für klinische Chirurgie* (Berlin, September 26, 1927) was in a boy of fourteen who had had a cæcostomy performed twelve years before.

The colon was practically a connective tissue tube with lumen completely obliterated. A successful ileoanostomy was effected. It seems probable, however, in this case that the length of time that the colon had been short circuited in a growing child from age two to age fourteen may have been a determining factor in the connective tissue obliteration.

While the above operative procedure is advocated for the colitis when active, superimposed polyposis, stricture either benign local or diffuse, or malignancy must be treated as sequelæ of the disease and make their individual indications for other well chosen operative procedures.

In the present series of cases, nine were operated upon. The procedures used were appendicostomy 1, ileosigmoidostomy 1, colostomy other than in cæcum 3, cæcostomy 4. Some of these procedures were unquestionably chosen without a complete understanding of the extent of the pathological lesion. Three deaths occurred—1 ileosigmoidostomy, 36 hours post-operative; 1 colostomy, 8 days post-operative; 1 colostomy, 10 days post-operative with a profuse hemorrhage from the colostomy opening. Of the four cæcostomy operations, all were well but constipated when last seen; two were closed—one acute case at the end of eleven weeks, one subacute case at the end of six months; one disappeared from observation, one wears a colostomy bag and does not wish to stop work for operation. All of these cases, except one appendicostomy and one cæcostomy, were severe cases either as acute phlegmonous cases or as acute exacerbations of chronic cases.

Conclusions.—Ulcerative colitis is a disease of diverse clinical and pathological manifestations. Its diagnosis and its significance when diagnosed are frequently overlooked.

Diagnosis can be made definitely by the sigmoidoscope or X-ray.

The type of inflammation in acute cases strongly suggests a streptococcus or closely allied Bagen's diplococcus as the etiologic factor. Such bacteriological investigation, however, to be valuable must be careful, painstaking and laborious. It must be done by the highly skilled worker.

Acute cases, or resistant subacute cases, or chronic cases with acute exacerbations should receive the benefit of surgical treatment promptly.

Liberal cæcostomy provides adequate drainage, opportunity for irrigation, easy secondary closure.

Transfusions, irrigations, topical sigmoidoscopic treatment, and possibly specific vaccine therapy are all aids in the cure of the patient.

A NEW TYPE OF PERMANENT COLOSTOMY*

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AND

CLAUDE F. DIXON, M.D.

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PERMANENT colostomy is necessarily a fairly common surgical procedure. The idea of an artificial anus is not appealing to the person who should have one, and, unless he is suffering from obstruction when he is told that he has carcinoma of the rectum and that an opening should be made to allow the bowel to empty from an opening in the abdomen, he may choose to have nothing done as long as he can use the anus, reserving colostomy for relief of later obstruction, especially if the local extension, metastasis, or the severity of the disease gives little or no hope of cure. However, he usually accepts the colostomy if it permits eradication of the disease.

In the pre-antiseptic period when it became necessary to make an artificial anus, some surgeons found that the safest place to make it was on the posterior lumbar aspect of the body where the descending colon could often be opened without opening the peritoneum. In this period a structure such as the anus had apparently never been particularly proud of its function and an artificial one was therefore so placed that its remoteness from vision caused no complaint from even the most fastidious folk. When such a condition as carcinoma of the transverse colon existed and a stoma in the ascending colon was necessary as an emergency, liquid feces passed continually. While the posterior outlet after a Kraske rectal resection pleased the patient because it was out of sight, it was most certainly never out of mind. It was sentiment and not sense that dictated an uncontrolled outlet

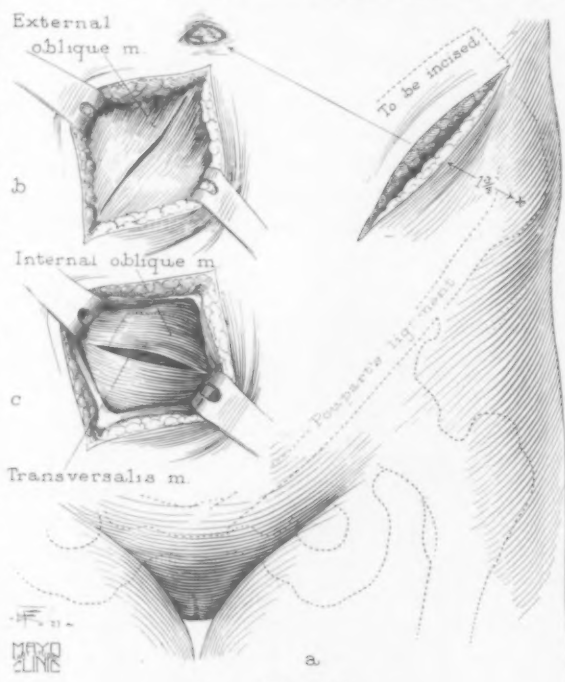


FIG. 1.—The incision.

* Read before the Southern Surgical Association, December 13, 1927.

in the anal region, especially when the sigmoid loop as a fecal reservoir had been lost or shortened. Such a vent was often satisfactory in carcinoma of the anus or lower part of the rectum, which could be excised without opening

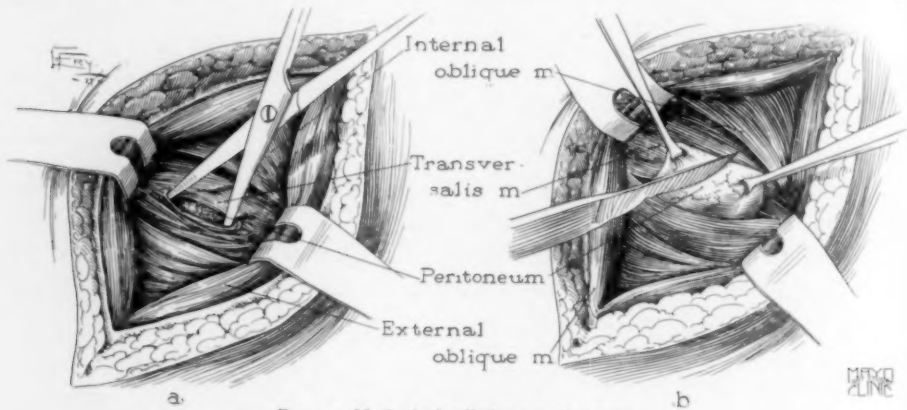


FIG. 2.—Method of splitting muscle layers.

the peritoneum, and without loss of the sigmoid storage function. Many types of colostomy have been described and many of them accomplish the purpose for which they were intended. Some work too well, that is, the

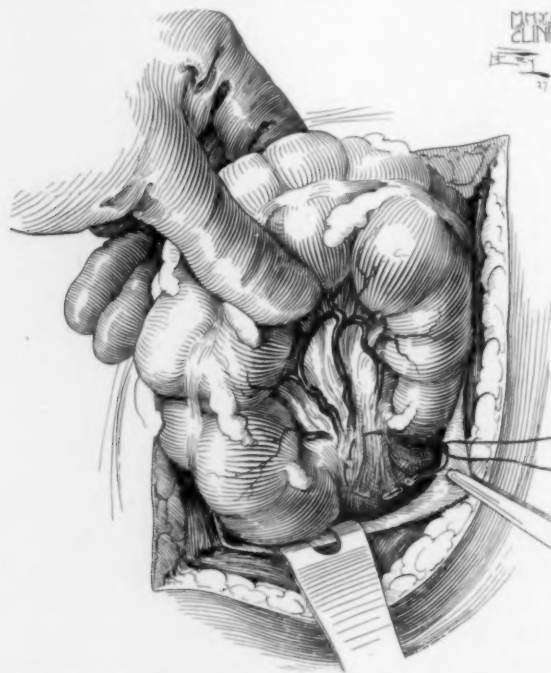


FIG. 3.—Method of obliterating lateral peritoneal pocket.

stoma is constantly soiled; in others, the attempt to obviate constant drainage has overreached itself and the stoma has been made in such a way that a great deal of effort is necessary to get it to work freely enough. When the stoma is made as a spur by drawing out a loop of bowel over a sustaining rod, more or less fecal matter passes into the lower part of the bowel.

Unquestionably the ideal stoma, if it can qualify for the use of such an adjective, is one which can be seen and is easily managed and cared for. The anterior stoma is much more satisfactory than the type which used to be made which necessarily carried the patient back to infant life.

The type which we are about to describe represents merely a change in

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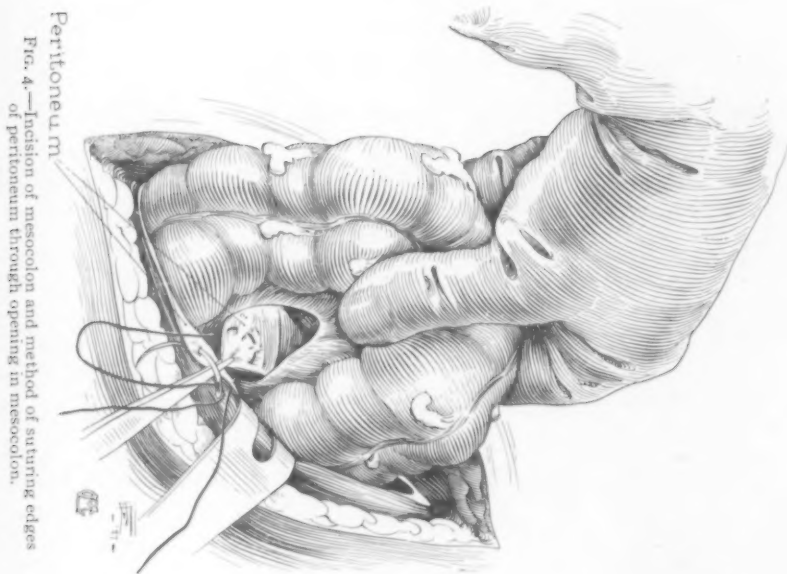


FIG. 4.—Incision of mesocolon and method of suturing edges of peritoneum through opening in mesocolon.

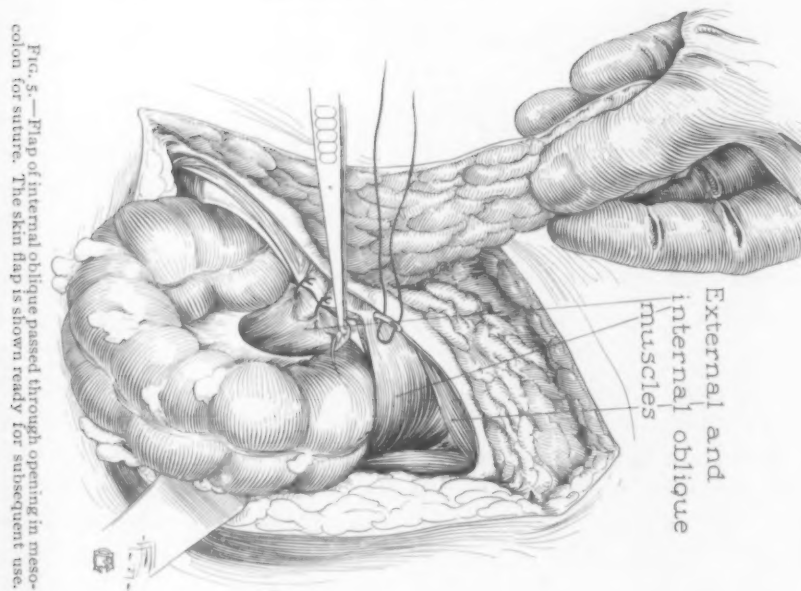


FIG. 5.—Flap of internal oblique passed through opening in mesocolon for suture. The skin flap is shown ready for subsequent use.

technic and not actually a new operation in principle. In this we have endeavored to plan an artificial anus which would give the patient relief from obstruction and at the same time perhaps provide sufficient control so that the patient might take his place in life as before without a cumbersome apparatus or the risk of hernia which its vacuum suction entails.

DESCRIPTION OF OPERATION

A lower left abdominal incision is made about 10 or 12 cm. in length and about 4 cm. to the mesial side of the left anterior superior spine parallel with

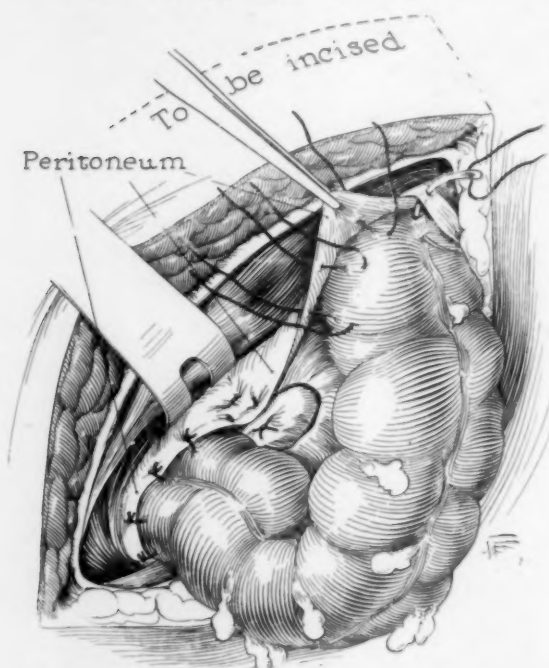


FIG. 6.—Remainder of peritoneum being sutured to sigmoid.

Poupart's ligament. (Fig. 1.) The upper third of the incision extends above the iliac crest. The external oblique fascia is divided in line with the skin incision and the internal oblique and transversalis muscles divided in line with their fibres in the centre of the incision. (Fig. 2a.) The peritoneum is then opened and exploration carried out. (Fig. 2b.) The descending colon is then brought out of the incision with no slack bowel above, as this will prevent possible later prolapse of bowel through the stoma. This also allows sufficient slack below in case posterior

resection is to be carried out later. The peritoneal pocket lateral to the sigmoid mesentery is closed by a purse-string suture of the lateral peritoneal fold. (Fig. 3.) This is an important step because if it is not carried out, a loop of the small intestine may herniate by the side of the stoma and become obstructed; death has been known to occur from this complication.

Next, as shown in Figure 4, an opening large enough to pass two fingers is made in the mesocolon. This is made parallel with the vessels as nearly as possible. The original cut edges of the peritoneum are now brought through the opening in the mesocolon and sutured together. The internal oblique is separated from the rectus margin 2 cm. and cut back parallel with the internal oblique fibres 2 cm. This muscle flap is withdrawn to the lateral aspect of the sigmoid, pushed through the opening at the mesocolon and sutured to the edge of the rectus. (Fig. 5.)

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FIG. 7.—The external oblique has been sutured through the mesenteric opening and is being closed throughout. The skin flap is held in readiness for the next manœuvre.

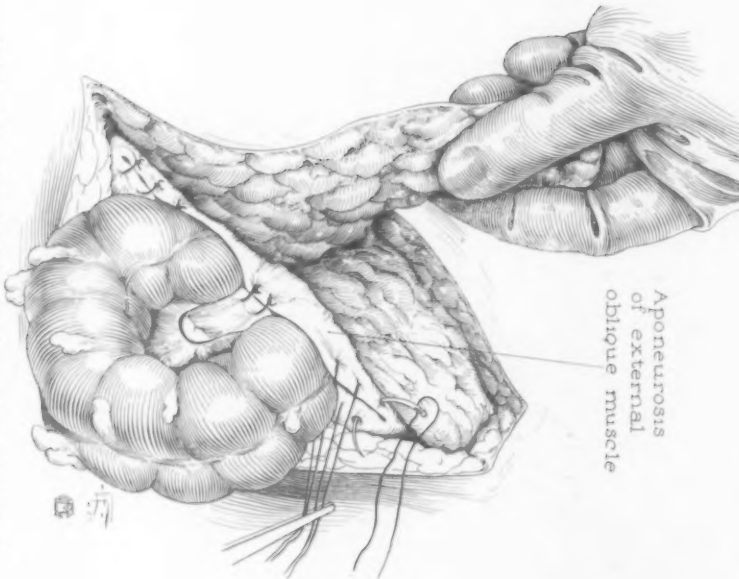
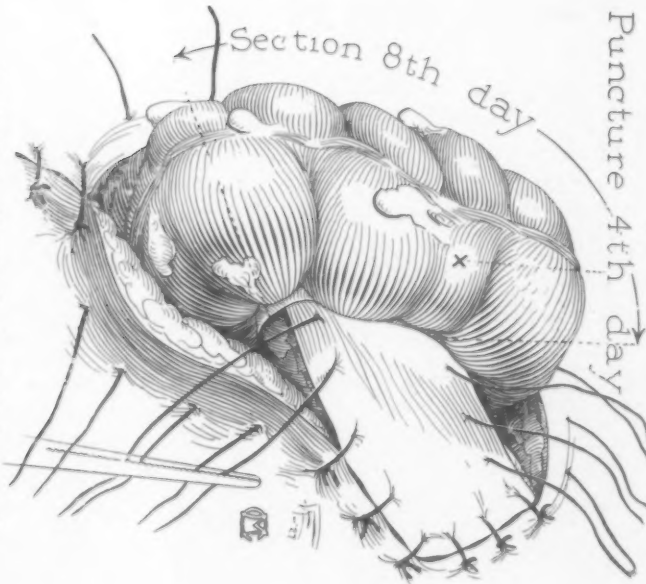


FIG. 8.—Proximal loop displaced and skin flap sutured.



The peritoneum is now sutured with interrupted No. 1 chromic catgut to the colon. (Fig. 6.) This is an important step in any colostomy, since it again guards against the possibility of the small intestine becoming obstructed by working its way into any opening which may be left. The sutures should not be inserted too deeply into the substance of the colon, but placed in thickened areas or where small fat attachments occur on the bowel.

The aponeurosis of the external oblique is now closed by means of interrupted sutures (Fig. 7); both sides of the aponeurosis are brought together through the mesocolon and sutured, as were the peritoneum and muscle; hernia is thus prevented.

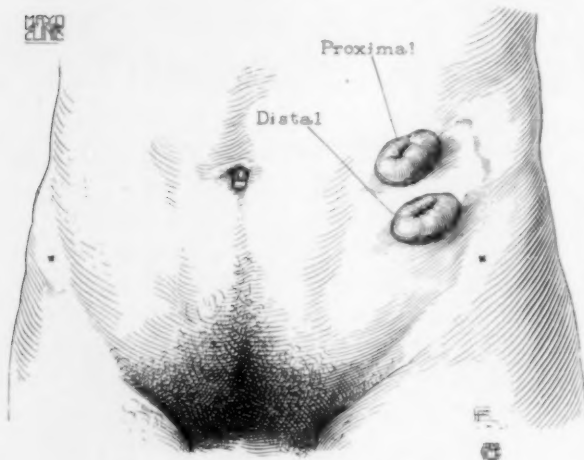


FIG. 9.—Appearance after resection of loop.

The skin flap which is also to be brought through the mesocolic opening is now made by cutting with scissors, as shown in Figure 1; from the upper end of the incision the skin is cut at right angles mesially for about 3 cm., then parallel to the original incision and about half-way its length and the flap lifted with free fat attached. The flap (Fig. 8) is then brought

through the mesocolon, and sutured back to the place from which it was taken (the proximal portion of the loop of intestine being displaced mesially). Interrupted plain catgut sutures are used.

On the third or fourth day after operation a small opening is made with a cautery in the knuckle of the colon for the escape of gas. On the seventh or eighth day after operation a wedge-shaped piece of the colon is removed, leaving 0.8 cm. of bowel projecting at each opening. Figure 9 shows the colostomy completed. Two days later the upper loop is irrigated to start elimination. The lower loop should be irrigated three or four times each week. If posterior resection is planned, it is carried out about twelve days after the original operation.

CONSIDERATIONS IN PERMANENT COLOSTOMY

If the tumor is not fixed or attached by adhesions to important structures and metastasis cannot be made out in the liver, resection is possible. We are not considering in this paper the cases in which the colon can be reunited after resection and the stoma closed later, but those cases in which a permanent stoma must be established.

The operation is not an emergency one and should not be attempted in the rare cases when immediate relief is imperative. Immediate opening is

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rarely necessary, but, if it is, another operation is necessary for exploration to determine the extent of the lesion and whether or not metastasis has occurred. A greatly distended bowel requires immediate relief without exploration as bacteria are flourishing just beneath the peritoneum and handling causes peritonitis. The abdomen is always carefully explored when the peritoneum is first opened, special attention being given to the liver and then the area of the carcinoma (the lower part of the pelvis in cases of rectal carcinoma) search being made for enlarged lymph-nodes along lower ureteral areas.

In practically all of our cases gas can be expelled through the rectum for several days after the colon is brought up for colostomy according to the method described. This operation had been performed in sixty-five cases up to January 1, 1928. We believe it gives better control than the usual type of colostomy. The muscle passing under the loop of bowel at one angle and the skin flap coming through at another, together with the fascia and peritoneum, exert considerable pressure on the proximal loop of colon, but do not cause obstruction.

In two cases of ours there was a slight slough of the skin flap due to tension. We have obviated this possible objection by placing an ordinary wooden tongue depressor under the loop of bowel after the skin flap has been sutured back in place. This distributes the pressure and tension on the skin, and primary union occurs.

We have had opportunity to see several of these stomas several months afterward and some more than a year later. Most patients use an elastic belt with a small amount of gauze over the stoma covered with toilet paper. Practically all of them have informed us that usually there is one movement from the stoma each morning and occasionally one in the evening. With the skin flap which we have described, the proximal and distal loops are more widely separated than in the usual type; this prevents the fæces from entering the distal loop.

We do not mean to imply that a colonic stoma adds pleasure to one's existence, unless one has endured obstruction, but in certain cases the condition has been made a little more bearable.

ABDOMINAL INJURIES IN CHILDREN *

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THE interpretation of abdominal pain in children is no mean task. "Belly-ache" is one of the commonest symptoms associated with the onset of the acute infectious diseases and nasopharyngeal infections. The evaluation of pain in acute appendicitis has in no measure made the mortality statistics of the child comparable with those of the adult. Pain resulting from traumatism to the abdomen, especially when unassociated with evidence of parietal injury is exceedingly difficult to interpret. Our diagnosis is of immediate vital importance only inasmuch as it differentiates between visceral damage, demanding surgical intervention, and abdominal wall injury of relatively small significance.

The pliant frame, thin abdominal wall and delicate omentum of the child are not well-adapted to withstand direct violence, which is transmitted directly to the viscera. A variable degree of shock results either from sympathetic nerve paralysis or rupture of a viscus. Pallor and rapid pulse are not necessarily indicative of shock, for fright may cause an increase of twenty to fifty beats per minute. In an older child, subjective examination is of importance as in the adult, but in a young child with abrasion of the abdominal wall, tenderness and rigidity, the problem is difficult. In a large percentage of instances, the associated injuries complicate the situation.

Children in large centres of population are subjected to frequent automobile and wagon accidents. The resulting casualties result fatally in most instances because of intra-abdominal injury, as disclosed by a study of 149 cases from private practice and the files of the Cook County and Mt. Sinai Hospitals, Chicago. Included in this series, also, were cases in which there was a history of injury to the abdomen from various mishaps. (Table I.)

There were 118 males and 31 females. The major number of accidents came under the heading of automobile and wagon—96 patients, 33 deaths, a mortality of 34 per cent. Children are curious, like to climb, so that falls are common. There were 25 such instances, with 5 deaths, a mortality of 20 per cent. Gunshot or stab wounds, involving abdomen or thorax, were surprisingly common—20 patients, 6 deaths, 30 per cent. mortality.

Symptoms.—Generalized or localized *abdominal pain* was noted in every one of the 126 conscious patients. Coma was present in 23; its basis will be explained later. The subjective story in children must be carefully weighed.

* The writer is indebted to his former chief, Dr. H. M. Richter, for permission to incorporate in this paper the material used in the section on "Surgery of the Gastro-intestinal Tract in Children," *Abt's Pediatrics*, vol. iii, pp. 485-503.

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The power of suggestion is very great. It is frequently desirable to give leading negative questions to be overridden by a positive response. Associated injuries often play an important part. Not infrequently the child with contusion, other than abdominal, complains of belly-ache, the exact origin of which is difficult to explain. Above all, in the examination of the child, one should bear in mind the advice of Dr. H. M. Richter, "the hand and heart of the examiner should be warm."

The incidence of vomiting could not be accurately ascertained. It was

TABLE I.

Age	Number of cases	Type of accident	Number of cases	Deaths	Per cent. mortality	
3	4	Automobile accident	76	26	34	
4	4	Wagon injury	20	7	35	
5	13	Fall {	From roof	11	3	27
6	12		Down stairs	4	1	25
7	16		On sharp pole	3		
8	18		On picket fence	2	1	50
9	10		From ladder	2		
10	19		From telegraph pole . . .	1		
11	5		On curb	1		
12	6		From train	1		
13	9					
14	18	Gunshot	16	6	37	
15	8	Stab	4			
16	7	Kicked in abdomen	3	1	33	
Total	149	Crushed between vehicles . . .	2			
		Kicked by horse	1			
		Crushed by elevator	1	1	100	
		Gas explosion	1	1	100	
			149	47	31	

recorded in 46 patients by direct observation. Emesis is so frequent in the young that it must have occurred in a considerable number of instances prior to admission to the hospital. No conclusions could be drawn as to the frequency of hæmatemesis, usually resulting from swallowed blood.

Evisceration was present in five children. Two had suffered stab wounds, two had been impaled on a picket fence, and in one the abdominal parietes were ruptured in a gas explosion. The omentum was the presenting viscus in two instances, the small bowel in three. Two of the children died.

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Abdominal wall injury was visible in 87 patients. In 21 the parietes were punctured. More important than these figures was the absence of abrasion, contusion, laceration or puncture in 62. This group will be discussed later.

Tenderness, a physical sign, is in no sense synonymous with pain, which is subjective. Local or diffuse soreness was present in 109 children, and absent in 17. *Rigidity* was recorded in 97 instances and was absent in 29. The 23 patients, who were admitted in coma, were not included in this series. No patient, in whom there was an absence of tenderness or rigidity, came to operation. *Distention*, varying in degree, was present in 35 children. Injuries, other than abdominal, were noted in 75 cases. The fractures

TABLE II.

	Diagnosis	Operation	Result
1	Injury to left kidney; fractured ribs.....		Recovery.
2	Injury to right kidney.....		Recovery.
3	Injury to left kidney.....		Recovery.
4	Perforated cæcum, ileum and rectum; subserous hæmatoma of urinary bladder	+	Recovery.
5	Gunshot of chest and left kidney.....		Recovery.
6	Fractured pelvis.....		Recovery.
7	Injury to left kidney.....		Recovery.
8	Injury to left kidney.....		Recovery.
9	Fractured pelvis.....		Recovery.
10	Injury to left kidney.....		Recovery.
11	Fractured pelvis.....		Death.
12	Intracapsular hæmatoma left kidney.....	+	Death.
13	Retroperitoneal hemorrhage; urinary extravasation	+	Recovery.
14	Hemoperitoneum; ruptured ileum.....	+	Recovery.

were—skull 2, spine 2, pelvis 4, clavicle 1, ribs 11, colles 1, femur 1, and tibia and fibula 1.

The *temperature* on admission to the hospital was determined in 131 patients. Subnormal temperature was seen in 21 children (16 per cent.), normal temperature in 30 (23 per cent.) and elevation in 80 (61 per cent.). Of the total series of 149 patients, 99 were admitted to the hospital within one hour of injury, indicating that in the majority of instances fever is to be expected.

Pulse rate was not determined as an aid in early diagnosis. In young children, direct cardiac auscultation is essential, but the rate is greatly influenced by the factors of fright and excitement, as previously mentioned. It is unfortunate that blood-pressure observations were not made in every

ABDOMINAL INJURIES IN CHILDREN

case. The diagnosis of shock can scarcely be made in the absence of definite depression of the blood-pressure. Many children presenting pallor, cold perspiration and rapid pulse showed a decided elevation of pressure. A small

TABLE III.

	Diagnosis (Patients admitted in coma)		Death in
1	Fractured ribs, vertebræ, sacrum and ileum; ruptured right kidney and adrenal; ruptured abdominal wall	Autopsy	1 hour.
2	Huge fresh tear of abdominal wall; multiple lacerations of omentum and intestine	Autopsy	1 hour.
3	Fracture of 3rd to 11th ribs; laceration of liver and spleen; hemoperitoneum	Autopsy	½ hour.
4	Fractured ribs; torn liver, lung, right adrenal; laceration of right heart atrium; free blood in chest, abdomen and pericardial sac	Autopsy	½ hour.
5	Enormous liver laceration and hemoperitoneum	Autopsy	2 hours.
6	Liver torn in half; right adrenal crushed	Autopsy	2 hours.
7	Rupture of liver and right adrenal; fractured femur	Autopsy	1 day.
8	Vertical deep tear of liver; hemoperitoneum; hemothorax..	Autopsy	4 hours.
9	Laceration of left lung and spleen; hemoperitoneum; fractured ribs	Autopsy	2 hours.
10	Hemoperitoneum; ruptured liver	Autopsy	½ hour.
11	Internal injuries	Clinical diagnosis	1 ½ hours.
12	Internal injuries	Clinical diagnosis	2 hours.
13	Internal injuries; suspected fracture of spine	Clinical diagnosis	¾ hour.
14	Internal injuries; multiple rib fractures; pneumothorax. . .	Clinical diagnosis	1 ½ hours.
15	Internal injury, hemorrhage and shock	Clinical diagnosis	½ hour.
16	Dissection of deep tissues from left thigh and buttock; internal injuries	Clinical diagnosis	5 days.
17	Fractured pelvis; ruptured viscera; hæmaturia	Clinical diagnosis	1 hour.
18	Internal injuries; laceration extending through anus and vagina through the fold between the nates to each thigh; deep hemorrhage of the thighs	Clinical diagnosis	10 minutes.

cuff, especially adapted for children, should be in the equipment of institutions, receiving emergency cases.

The *leucocyte count* was determined in 29 patients on admission to the hospital and was definitely increased above normal in 65 per cent. (above

12,000); markedly so in one case (60,000) in the absence of demonstrable visceral injury. In 22 cases, with pathology determined by operation or autopsy, the leucocyte counts ranged from 9800 to 39,600. There was a leucocytosis in three of four patients with abdominal wall injury. No relationship could be demonstrated between the height of the white blood count and the severity of injury. It is unfortunate that an equal number of leucocyte determinations was not made in patients with parietal injury alone, as leucocytosis is commonly present in patients with multiple contusions.

Hematuria, indicating urinary tract injury, was present in 14 children, as shown in Table II.

Coma, on admission to the hospital, was present in 23 patients, of whom 19 died and 4 recovered. Death occurred six hours after operation for repair of ruptured ileum in one child. The four children who recovered were all operated on with the following findings: (1) Rupture of the ileum repaired; (2) hemoperitoneum but injured viscus not demonstrated; (3) ruptured spleen packed; (4) rupture of splenic flexure of colon repaired. Eighteen deaths are accounted for in Table III. Postmortem examinations were secured in 10, while in 8 permission for necropsy was refused. Death occurred within one hour in 9 instances. On the whole the injuries were so extensive that treatment was out of the question.

Diagnosis.—In order of importance and frequency the commonest early symptoms in this series of 149 cases were *abdominal pain, tenderness, rigidity, abdominal wall injury, moderate elevation of temperature, vomiting and leucocytosis*. A further analysis of the predominating symptoms reveals some instructive facts relative to diagnosis, the immediate purpose of which is the determination as to whether a watchful policy of expectancy is to be pursued or the patient operated upon at once. The weightiest symptoms are unfortunately those over which the child has considerable subjective control, just as in non-traumatic surgery. Degree of pain is no measure of extent of injury. The differentiation between voluntary and involuntary rigidity must be very carefully made. The decision as to whether local tenderness and rigidity in the presence or absence of abdominal wall abrasion, contusion or laceration indicates visceral damage, must rest upon the associated findings.

In studying the records of 29 children who came to operation, exclusive of cases of evisceration and gunshot wounds, it is evident that the apparent local rigidity and tenderness indicated the exact site of visceral damage in 15 cases and was of no value in 14. The clinical diagnosis was confirmed in 10 instances, was incorrect in 5 and questionable in 14. (See Table IV.)

A review of the records of patients who were autopsied, seemingly indicates that local tenderness and rigidity were of even less value. Visceral damage was correctly indicated in but one case, and local findings were of no value in 14. The clinical diagnosis was correct in only 1 case, was incorrect in 7 and questionable in 7. (See Table V.) However, four of these

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TABLE IV.

Value of Tenderness and Rigidity in Comparison with Operative Findings.

	Site of tenderness and rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis	Operative findings
1	Right iliac and lumbar	Positive	Urinary tract injury	Correct	Right retroperitoneal hemorrhage, urinary extravasation.
2	Left lumbar	Positive	Left kidney injury	Correct	Intracapsular hæmatoma left kidney.
3	Entire abdomen	Negative	Ruptured intestine	Correct	Ruptured ileum.
4	Entire abdomen	Negative	Internal injuries	Incorrect	Hæmatoma of abdominal wall; no injured viscus.
5	Left hypochondrium	Positive	Pleural hemorrhage	Incorrect	Ruptured spleen.
6	Left lower quadrant	Negative	Ruptured ileum	Incorrect	Rupture splenic flexure colon.
7	Entire abdomen	Negative	Injured viscus	Questionable	Ruptured edge of right lobe of liver.
8	Left lumbar	Positive	Injured left kidney	Correct	Rupture through pelvis of left kidney.
9	Left hypochondrium	Positive	Ruptured spleen	Correct	Ruptured spleen.
10	Diffuse	Negative	Ruptured liver	Correct	Ruptured mesentery and liver.
11	Left iliac	Positive	Peritonitis. Ruptured intestine	Correct	Perforated ileum.
12	Right hypochondrium	Positive	Injured viscus	Questionable	Ruptured liver.
13	Left hypochondrium	Positive	Ruptured spleen	Correct	Ruptured spleen.
14	Left hypochondrium	Negative	Internal injuries	Questionable	Hemoperitoneum; injured viscus not found.
15	Left hypochondrium	Negative	Internal injuries	Incorrect	No findings.
16	Lower quadrants	Negative	Abdominal hemorrhage	Questionable	Torn mesentery. Free blood.
17	Right hypochondrium	Positive	Internal injuries	Questionable	Lacerated liver.
18	Right hypochondrium	Positive	Internal injuries	Questionable	Ruptured right lobe of liver.
19	Right lower quadrant	Negative	Internal injuries	Questionable	Torn transverse colon and mesocolon.
20	Diffuse	Negative	Internal injuries	Questionable	Ruptured spleen.

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TABLE IV.—*Continued.*

	Site of tenderness and rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis	Operative findings
21	Left iliac	Positive	Internal injuries	Questionable	Lacerated ileum and mesentery.
22	Right half	Negative	Internal injuries	Questionable	Hemoperitoneum, injured viscus not found.
23	Umbilical	Positive	Internal injuries	Questionable	Ruptured ileum.
24	Right iliac and umbilical	Positive	Ruptured ileum	Correct	Ruptured ileum, peritonitis.
25	Epigastric and right iliac	Negative	Ruptured stomach	Incorrect	No findings.
26	Right hypochondrium	Positive	Ruptured liver	Correct	Ruptured liver.
27	Diffuse	Negative	Ruptured viscus	Questionable	Ruptured spleen and pancreas; hemoperitoneum.
28	Left hypochondrium	Positive	Internal injuries	Questionable	Ruptured splenic flexure colon; peritonitis.
29	Diffuse	Negative	Internal injuries	Questionable	Ruptured liver; hemoperitoneum.

Tenderness and rigidity of value in 15 cases; of no value in 14 cases.

Clinical diagnosis correct in 10 cases, questionable in 14 cases, and incorrect in 5.

patients were admitted to the hospital in coma, and in the remaining eleven death occurred shortly after admission.

Exclusive of the 18 patients brought to the hospital in coma, 97 of the remaining 126 (77 per cent.) exhibited abdominal tenderness and rigidity. This was misleading in four laparotomized children who showed no visceral injury. No child with absence of tenderness and rigidity came to operation, indicating that these physical findings are the most significant diagnostic criteria. In addition, of considerable import is the history of the force applied to the abdomen. Obviously, the history of the passage of a vehicle over the abdomen, or a violent blow, producing mild tenderness and rigidity, is more suggestive of visceral damage than a lighter force resulting in more marked symptoms. Increasing and spreading rigidity is more suggestive of visceral than parietal damage and is more marked with rupture of the hollow viscera and its consequent peritonitis than with laceration of the solid organs and hemorrhage.

The final decision as to whether a given patient demands early laparotomy rests upon a correlation of all the symptoms. Following an initial greater or lesser degree of shock, the picture of a rising pulse, with elevation of temperature, incidence of vomiting, tenderness and rigidity, and the gradual development of distention, suggests rupture of the intestine. The obliteration of liver dullness and the presence of shifting dullness in the flanks are

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TABLE V.
Value of Tenderness and Rigidity in Comparison with Postmortem Findings.

	Sign of tenderness and rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis	Postmortem findings
1	Not localized . . .	Negative	Multiple contusions	Incorrect	Ruptured liver and spleen.
2	Diffuse	Positive	Paralytic ileus; peritonitis	Correct	Peritonitis; ruptured bowel.
3	Hypogastric	Negative	Ruptured viscus; skull fracture	Questionable	Ruptured liver and hemothorax.
4	Diffuse	Negative	Skull fracture	Incorrect	Ruptured spleen, liver ileum.
5	Diffuse	Negative	Internal injuries	Questionable	Lacerated liver.
6	Right lower quadrant	Negative	Internal injuries	Questionable	Ruptured ileum; peritonitis.
7	Diffuse	Negative	Multiple contusions	Incorrect	Crushed liver.
8	Diffuse	Negative	Internal injuries	Questionable	Left hemothorax; lacerated liver.
9	Diffuse	Negative	Left pneumothorax; skull fracture	Incorrect	Lacerated spleen and lung.
10	Epigastric; right lower quadrant	Negative	Ruptured stomach	Incorrect	Torn lung.
11	Diffuse	Negative	Internal injuries	Questionable	Hemoperitoneum, ruptured liver.
12	Not localized (coma)	Negative	Internal injuries	Questionable	Lacerated liver and spleen; hemorrhage of left lung; fracture 3 to 12 left ribs.
13	Not localized (coma)	Negative	Basal skull fracture; internal injuries	Questionable	Torn liver and right lung, right adrenal and heart.
14	Not localized (coma)	Negative	Skull fracture	Incorrect	Torn liver and right adrenal.
15	Not localized (coma)	Negative	Skull fracture	Incorrect	Rupture of liver and right adrenal.

Tenderness and rigidity of value in 1 case; of no value in 14 cases.

Clinical diagnosis correct in 1 case; questionable in 7 cases; incorrect in 7 cases.

minor though valuable signs. Fluoroscopic examination of the abdomen is of great value in determining the presence of free gas in the peritoneal cavity, resulting from intestinal rupture (Vaughan).†

If extensive, injury to the solid viscera—liver, spleen, kidneys, adrenals, and pancreas, in order of frequency—is attended with massive hemorrhage

† Vaughan, R. T., and Brams, W. A.: Röntgen-ray in the Diagnosis of Perforated Peptic Ulcer. J. A. M. A., vol. lxxxv, pp. 1876-1878, December 12, 1925.

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and early death. The picture of shock resulting from hemorrhage is more prolonged than in rupture of a hollow viscus. In lesser injuries the bleeding may cease spontaneously, and the clinical course is less stormy than with intestinal rupture. Urinary tract damage is usually accompanied by hæmaturia, though the exact level of injury may be difficult to determine. Early catheterization and cystoscopic examination should not be carried out as the danger of secondary infection is too great.

The discussion of gunshot and stab wounds and evisceration has been

TABLE VI.
Operative and Postmortem Findings in Patients Without Abdominal Wall Injury.

	Operative cases	Result		Necropsies
1	Intracapsular hæmatoma of kidney	Death	1	Ruptured ileum; diffuse peritonitis.
2	Ruptured mesentery and liver....	Death	2	Liver torn in half; right adrenal crushed.
3	Lacerated liver.....	Death	3	Ruptured liver and right adrenal.
4	Rupture of right lobe of liver....	Death	4	Liver and right lung lacerated.
5	Exploratory, no findings.....	Recovery.		
6	Rupture of ileum with peritonitis..	Recovery.		
7	Rupture of splenic flexure of colon; hemoperitoneum	Recovery.		
8	Ruptured liver.....	Recovery.		
9	Hemoperitoneum; injured viscus not found	Recovery.		
10	Exploratory, but no findings....	Recovery.		
11	Hemoperitoneum; torn mesentery	Recovery.		
12	Ruptured spleen.....	Recovery.		
13	Hemoperitoneum; injured viscus not found	Recovery.		
14	Hemoperitoneum; ruptured liver..	Recovery.		

omitted because of the obvious possibilities of visceral injury. A source of error that must not be overlooked is damage to the abdominal viscera, where a bullet enters the chest or thigh at a distance from the abdomen. The possible course of the bullet must be borne in mind. Upper abdominal injury may be confused with thoracic damage. The fluoroscope and in its absence thoracentesis may clear the diagnosis.

The absence of abdominal wall injury can in no sense exclude the possibility of intra-abdominal visceral damage. Thus there was evidence of parietal injury in 87 children, 66 non-penetrating (30 deaths, 45 per cent. mortality), and 21 penetrating (9 deaths, 43 per cent. mortality). Lapa-

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rotomy was performed in 29 instances with 10 deaths, a mortality of 34 per cent. There was no sign of abdominal wall injury in 62 children, and the mortality was 13 per cent. (8 deaths). The abdomen was opened in 14 instances with 4 deaths (mortality 28 per cent.). The operative findings are tabulated in Table VI. In Cases V and X, there were no findings. However, laparotomy is justified whenever there is a reasonable doubt as to visceral injury and the patient's general condition is good. Free blood in the peritoneal cavity does not necessarily mean visceral injury, as hemorrhage from the abdominal wall or retroperitoneal tissues may readily occur.

Mortality.—The mortality rate is dependent upon such factors as character of the injury, extent and nature of visceral damage, time elapsing from injury to treatment, and age of the child. The younger the patient, the more serious the outlook. Hemorrhage and shock are poorly borne by young children. Direct violence to the abdomen may be sharply defined or diffuse. Crushing injuries are of the latter type and are obviously more frequently followed by rupture of solid or hollow viscera. In the series of 149 cases studied, 96, resulting from automobile and wagon accidents, were of this nature. There were 33 deaths, a mortality of 34 per cent. The remaining 53 patients had a death rate of 26 per cent. Gunshot and stab wounds occurred in 20 patients, with 6 deaths, 30 per cent. mortality.

The extent and nature of visceral damage are the most important factors in determining mortality. Evisceration is attended with considerable shock, and the result depends upon the length of exposure and the condition of the peritoneum. In five children, the abdominal viscera protruded. One fell on a picket fence, and the small bowel was exposed for two hours; but the stomach was perforated, and the abdomen full of blood, death resulting within 24 hours. In another, the abdominal wall was ruptured from xiphoid to right ilium, following a gas explosion, death occurring within an hour. Three recovered; in two the omentum and bowel were exposed for an hour, in the third the abdominal wall was ruptured 18 hours prior to admission to the hospital.

Death from hemorrhage follows rupture of the solid viscera more frequently than of the hollow organs. Where massive hemorrhage does not immediately cause death, injury to the liver, spleen, kidneys or mesentery offers a relatively good prognosis, providing adequate surgical interference is promptly employed. Rupture of the hollow organs results fatally, rather from secondary peritonitis than from hemorrhage. Thus gastric or intestinal perforation must be promptly corrected, as the mortality rises with great rapidity with each hour of delay.

There were 16 cases of rupture of the stomach or intestines with involvement of the ileum 6 times, stomach 4, colon 3, jejunum and colon 1, ileum and colon 1, and cæcum, ileum and rectum 1. (Table VII.) There were 6 deaths, Cases 9, 10, 12, 13 and 14 showing extensive injury with death within four hours from time of injury. The promptness of operative treatment was probably a very important factor in the recovery of ten children.

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In the 149 cases there were 43 laparotomies, with 14 deaths (mortality 32 per cent.). After admission to the hospital, operation was carried out within two hours on the average, with the exception of 4 patients; one was laparotomized after 14 hours for rupture of the spleen, another after 32 hours for lacerated liver, the third after 2 days for injury to a kidney, and the

TABLE VII.
Results of Operation for Rupture of Stomach or Intestines.

Case	Organ	Time elapsing from injury to operation	Result	
			Recovery	Death
1	Ileum.....	2 hours	+	
2	Stomach.....	4 hours	+	
3	Jejunum and colon.....	2 hours	+	
4	Ileum.....	4 hours	+	
5	Colon.....	5 hours	+	
6	Ileum.....	3 hours	+	
7	Ileum.....	2 hours	+	
8	Ileum.....	2 hours	+	
9	Ileum and colon (nine perforations).....	2 hours		+
10	Stomach—(abdomen full of blood, protruding omentum and small intestine; stomach contents in abdomen; perforated cardiac end of stomach)	2 hours		+
11	Transverse colon—(injured 18 hours prior to admission)	20 hours		+
12	Stomach—(perforation cardiac end of stomach with omental plug; hemorrhage in lower pole of spleen)	2 hours		+
13	Ileum—(free blood; ileum torn in two).....	4½ hours		+
14	Cæcum and ileum—(perforated cæcum and ileum; right iliac hemorrhage; subserous hæmatoma of bladder; hole in rectum; marked hemoperitoneum)	1 hour		+
15	Colon.....	10 hours	+	
16	Stomach.....	4½ hours	+	
	Total		10	6

fourth after 9 days for urinary extravasation. There were 33 deaths among the remaining 106 non-operated children (mortality 31 per cent.). In 16 of the 33, death ensued on the average within two hours of admission as the result of extensive injury. (Table III.) The time of death after admission to the hospital is shown in Table VIII for non-operated patients.

The time elapsing from injury to treatment is very important as previously indicated (Table VII.) Admission to the hospital was within one

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hour of injury in 99 cases and within six hours in 135. The remaining 14 children were admitted from 1 to 30 days after accident. The promptness of treatment would lead one to expect a comparatively low mortality rate. The actual figure of 31 per cent. brings home the seriousness of abdominal injury. The complete postmortem examinations of 17 children are listed in Table IX.

Treatment.—The treatment of abdominal injury in children, whether parietal or visceral, should first combat shock. In the first hour following

TABLE VIII.
Time of Death After Admission to Hospital (Non-operated Patients).

Time	Number of cases
1 hour.....	12
2 hours.....	4
3 hours.....	2
4 hours.....	1
5 hours.....	1
6 hours.....	2
9 hours.....	1
12 hours.....	2
24 hours.....	5
2 days.....	1
5 days.....	1
10 days.....	1

accident, it is often impossible to offer even a tentative diagnosis. Conservation of body heat and a minimum of handling is the best course. The treatment of associated minor abrasions, lacerations or fractures often detracts attention from the essential pathology, adds insult to injury and maintains or increases the picture of shock. Gentle manipulation, external heat, and simple hypodermic stimulation should be the first measures. Morphine must never be employed until the diagnosis is reasonably assured, as its early use may completely hide the true state of affairs.

Non-penetrating abdominal wall injury needs no discussion. Where the parieties have been perforated, it is better to enlarge the wound and explore, than to remain in doubt as to possible visceral injury. In the average case débridement and closure without drainage will suffice.

As a preliminary or sequel to operation no measure ranks higher than blood transfusion. Lack of familiarity with its technic in a large measure accounts for failure in its more general use. Institutions, receiving frequent emergency cases, should have a ready list of available grouped donors.

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Matching bloods is a simple procedure of a few minutes' duration. The method of administration is an individual matter. Any method that helps to restore blood volume and substance, maintain blood-pressure, and check hemorrhage, controls shock and saves life. In our experience, citrated

TABLE IX.
Postmortem Examinations.

1	Traumatic ruptured liver and spleen; hemoperitoneum; retroperitoneal hemorrhage; bruises of the head, trunk and thighs.
2	Contusions and abrasions of abdomen, back, hips, thighs, knees; fracture of the ribs, vertebræ, sacrum, ileum; dislocation of lumbar vertebræ; ruptured kidney and adrenal; ruptured abdominal wall.
3	Smoke and dirt begrimed; multiple lacerations and bruises all over the front of the body with many imbedded foreign bodies; huge fresh tear of abdomen.
4	Fractured 3rd to 11th left ribs; laceration of the liver and spleen; hemoperitoneum; hemorrhages of the left lung; abrasions of the face.
5	Traumatic subacute rupture of the bowel; general fibrino-purulent peritonitis; distention of the jejunum and ileum.
6	Crushing laceration of the liver and spleen and parietal pleura; hemothorax and peritoneum; splitting apart of soft tissues of trunk; fat embolism; persistent thymus; status lymphaticus; Frohlich's syndrome.
7	General bruises of the extremities; fracture of 3rd, 4th and 5th ribs; vertical tear of liver and right lung; torn right adrenal; laceration of right heart atrium; free blood in the abdomen and right chest and pericardium.
8	Bruises of the head, chest, back, limbs; liver and spleen torn; small bowel torn across; fractured pelvis; fractured left clavicle; free abdominal blood.
9	Bruising of the upper extremity; enormous laceration and crushing of the liver; fracture of the left 9th rib; free blood in abdomen (3 pounds).
10	Petechial hemorrhages of the face and forehead; liver torn in half; torn right adrenal.
11	Peritonitis following ruptured gut.
12	One-fifth of the liver crushed off from rest of liver, lying loose in the belly; free blood; fractured right 8th and 9th ribs; wounded right lung.
13	Ruptured liver and right adrenal; fractured femur.
14	Vertical deep tear of liver; hemoperitoneum; blood about left lung.
15	Traumatic laceration of lungs and spleen; hemoperitoneum; fractured ribs.
16	Torn lung.
17	Hemoperitoneum; ruptured liver.

blood has been best employed. Intraperitoneal transfusion should never be used in traumatic abdominal emergencies.

The value of transfusion is emphasized when we note that there were 36 children of the series with marked hæmoperitoneum (diagnosis verified by operation in 24 and by necropsy in 12), with 23 deaths. Of definite but less value is hypodermoclysis of normal saline. Where there is a ques-

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tion as to rupture of the stomach or intestines liquids by mouth or rectum should be withheld until after operation.

It is not the purpose of this paper to discuss operative technic and methods of treatment for injury to various organs, but rather to point out a few general salient points. General anæsthesia, adequate incision, gentle

TABLE X.
Average Time of Death After Rupture of Viscera.

Rupture of solid viscera		Rupture of hollow viscera	
Case	Death within	Case	Death within
1	½ hour	1	6 hours
2	1 ½ hours	2	6 hours
3	2 ½ hours	3	22 hours
4	3 hours	4	24 hours
5	3 hours	5	40 hours
6	4 hours	6	48 hours
7	4 hours	7	4 ½ days
8	6 hours		
9	10 hours		
10	12 hours		
11	20 hours		
12	20 hours		
13	24 hours		
14	24 hours		
15	30 hours		
16	72 hours		
17	82 hours		
	Average 18.6 hours		Average 36.2 hours

though rapid manipulation, and conservation of body heat, should form the basis of operation in these children.

Nitrous oxide or ethylene combined with local infiltration of the abdominal wall affords ideal anæsthesia. (Crile.) Novocain (½ per cent., with one minim 1:1000 adrenalin chloride to the ounce) reduces the amount and length of general anæsthetic required, gives excellent relaxation of the abdominal wall, and takes the edge from the early post-operative pain. This method of anæsthesia enables the patient to be awake before leaving the operating room and materially reduces post-operative vomiting.

The incision should be adequate, offering ready exposure. Long, drawn-

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TABLE XI.

	Operative findings	Operative procedures	Result
1	Nine perforations of small and large intestine; hemoperitoneum	Resection of one foot of ileum; other holes repaired	Death.
2	Herniation of omentum through stab wound; viscera uninjured	Protruding omentum cut off	Recovery.
3	Hemoperitoneum; injured viscus not found	Exploratory laparotomy	Recovery.
4	No findings	Exploratory laparotomy	Recovery.
5	Mesenteric tear; hemoperitoneum	Exploratory laparotomy	Recovery.
6	Protruding omentum and small intestine; perforated cardiac end of stomach; stomach contents in abdomen; hemoperitoneum	Stomach tears repaired; omentum ligated; mesentery sewed; stomach contents removed	Death.
7	Lacerated liver; hemoperitoneum	Liver rent packed with gauze	Death.
8	Rupture of right lobe of liver; free blood	Liver rent repaired with omentum; packs	Death.
9	Torn transverse mesocolon and hematoma; torn transverse colon; hemoperitoneum	Tears in bowel and mesocolon repaired	Death.
10	Perforated cardiac end of stomach with omentum plugging hole; hemorrhage in lower pole of spleen	Tear in stomach repaired	Death.
11	Omentum protruding through stab wound	Omentum ligated and cut off	Recovery.
12	Ruptured spleen; hemoperitoneum	Omentum packed into splenic rupture	Recovery.
13	Two lacerations of ileum and mesentery	Tears in ileum and mesentery repaired	Death.
14	Hemoperitoneum; no injuries found	Exploratory laparotomy	Recovery.
15	Ruptured small intestine; hemoperitoneum	Ileum repaired	Recovery.
16	No findings	Exploratory laparotomy	Death.
17	Retroperitoneal hemorrhage and urinary extravasation	Extraperitoneal removal of blood clot	Recovery.
18	Protruding omentum	External omentum ligated and cut off	Recovery.
19	Eighteen inches of eviscerated bowel (normal)	Bowel replaced	Recovery.
20	Intracapsular hematoma of left kidney	Kidney incised, clot removed and kidney replaced	Death.
21	Hemoperitoneum; effusions in mesentery	Exploratory laparotomy	Recovery.

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TABLE XI.—Continued.

	Operative findings	Operative procedures	Result
22	Ruptured ileum with distal segment thrombosed and inflamed; hemoperitoneum	Ileostomy; ileal perforation sutured	Recovery.
23	Hematoma of abdominal wall; no injured viscus	Exploratory laparotomy	Recovery.
24	Lacerated left lobe of liver; free blood	Liver tears sutured	Recovery.
25	Perforation cardiac end of stomach; and left lobe of liver; hemoperitoneum	Perforations in stomach repaired	Recovery.
26	Three perforations of jejunum; one perforation of mesentery; five perforations of colon; small amount of feces and free blood	Intestinal openings sutured; one ounce of ether poured into abdomen	Recovery.
27	Ruptured small bowel with free fluid and marked plastic free peritonitis	Laceration repaired	Recovery.
28	Ruptured spleen	Spleen packed	Death.
29	Rupture of splenic flexure of colon with free blood	Exploratory laparotomy	Recovery.
30	Ruptured edge of right lobe of liver	Exploratory laparotomy	Recovery.
31	Ruptured pelvis of left kidney; torn mesocolon; retroperitoneal urinary effusion	Left nephrectomy; repair of mesocolon	Recovery.
32	Ruptured spleen	Splenectomy	Recovery.
33	Ruptured mesentery and liver; free blood	Exploratory laparotomy	Death.
34	Perforated small bowel; free pus	Ileum sutured	Recovery.
35	Ruptured liver; free blood	Exploratory laparotomy	Recovery.
36	Transverse rupture of spleen; much free blood	Omentum placed between torn edges of spleen	Recovery.
37	Two perforations of ileum	Perforations of ileum sutured	Recovery.
38	Perforated cæcum and small bowel; subserous hematoma of bladder; perforated rectum; marked hemoperitoneum	Suture of perforations; drainage	Death.
39	Rupture of liver about falciform ligament; marked hemoperitoneum	Suture of rupture	Recovery.
40	Spleen lacerated and almost completely detached from pedicle; tail of pancreas separated from body; marked hemorrhage	Splenectomy	Death.
41	Ruptured splenic flexure of colon; diffuse peritonitis; paralytic ileus	Perforation in colon closed; jejunostomy; drainage	Recovery.
42	Rupture at right side of dome of liver; marked hemorrhage	Exploratory laparotomy; blood transfusion	Death.
43	Two perforations of stomach	Suture of holes	Recovery.

out dissections of the abdominal wall must be classed as bad surgery. This step in laparotomy should be the most rapid. Where definite localization is present, the place of incision is obvious. Exploratory incisions are best made above the umbilicus, median or paramedian. In 27 patients injury involved viscera of upper abdomen in 20 instances, of lower abdomen, in 7.

Injury to the solid viscera, when extensive, is rapidly fatal because of hemorrhage, hence the abdomen should be opened as soon as the diagnosis is made, and the anaemia offset by blood transfusion. Drainage, after repair of liver, spleen, kidney, mesentery or urinary bladder, is seldom, if ever, necessary. Packing of a laceration is a valuable procedure that involves an entirely different principle than drainage. In pancreatitis drainage is essential.

Injury to the stomach or intestines does not usually result fatally because of hemorrhage, unless associated with laceration of the solid organs. The danger from peritonitis is many times as great, so that each hour of delay increases the mortality. Table X shows that the average time of death after injury was 18.6 hours following rupture of the solid viscera in 17 children, and 36.2 hours after laceration of stomach, ileum or colon in 7 patients.

The fixed points of the intestine, duodeno-jejunal flexure and ileocaecal junction are most frequently ruptured, hence the examination should begin from these points. More than one rent in the bowel may be present. Needless evisceration is very harmful. Gross food or fecal matter should be removed, but prolonged toilet of the peritoneum is detrimental. Before suture of the perforation is begun, the integrity of the mesenteric circulation should be ascertained. At times a temporary ileostomy or colostomy may be a life-saving measure, where the condition of the patient will not warrant a necessary resection. Drainage should be determined by the presence of gross suppuration alone; this will rarely be necessary except in delayed cases. As the infectivity of the bowel increases toward the colon, drainage will more often be found necessary in injuries of the colon and rectum. Practically the only exceptions to the rule of non-drainage is exposure of the retro-peritoneal tissues, as in rupture of the posterior duodenum.

The findings in the 43 operated patients are listed in Table XI.

SUMMARY AND CONCLUSIONS

1. The study of 149 cases of abdominal injury in children indicates that the commonest early symptoms in order of importance are abdominal pain, tenderness, rigidity, abdominal wall injury, moderate elevation of temperature, vomiting and leucocytosis.
2. The mortality rate is dependent upon such factors as character of the injury, extent and nature of visceral damage, time elapsing from injury to treatment, and age of the child.
3. The early combating of shock, blood transfusion, combined local and general anaesthesia and adequate incision are important factors in successful treatment, in addition to the specific repair of the damaged viscus.
4. Laparotomy is justified whenever there is a reasonable doubt as to visceral injury, and the patient's general condition is good.

OPERATIVE MORTALITY AND END RESULTS IN GALL-BLADDER SURGERY

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THE author's first paper on gall-bladder surgery was read before the section on Surgery and Anatomy when the American Medical Association met in New Orleans in 1903, and was a plea for cholecystectomy. As an indication of my trend of thought at that time, permit the quotation of a single sentence from that paper: "After a gall-bladder has been as profoundly diseased as it usually is when made the object of surgical attack, it never regains its normal state and is henceforth not only valueless, but on account of its defective drainage is constantly subjected to the risks of fresh infection." At that time the so-called radical views expressed were made the object of a sweeping criticism by John B. Murphy, A. J. Ochsner, W. J. Mayo and others.

Before the Nebraska State Medical Association, in 1921, a summary was made of 563 cases of gall-bladder operations. About one-half of these cases were subjected to cholecystectomy and the other half were drained. The operative mortality of this series was 8.17 per cent. Since that time there has been a gradual reduction in the mortality and a steady increase in the number of removals of the viscus.

In the present communication I submit a later experience in which it has been attempted to make as close an analysis as possible of the causes of the operative mortality, and the reasons for failure to cure all the cases. To this end 160 consecutive cases of gall-bladder surgery are hereby submitted for study.

There are 132 females in the series and 28 males, or a little more than four females to one male. There were six operative deaths, or 3.75 per cent. mortality. It may prove profitable to analyze the deaths and endeavor to discover how some of the fatalities might have been prevented. Of the 160 operations, 156 cholecystectomies were performed and only 4 cholecystostomies, or in 97.5 per cent. of the cases operated on the gall-bladder was removed. Two of the deaths followed cholecystostomy. This is not meant to be an argument for the greater safety of cholecystectomy, but to show that drainage is resorted to only in the very serious cases.

Analysis of the Operative Deaths.—Death No. 1. The first death in the series was a cholecystectomy done for cholecystitis and was a very easy case and there was no anxiety about the outcome. The patient was a strong man, he did well for a few hours, then developed a streptococcic sore throat with acute abdominal pain and succumbed four days later of streptococcic peritonitis, confirmed by blood culture and autopsy. This was just at the beginning of an outbreak of streptococcic sore throat among nurses and patients and all operations except cases of extreme emergency were suspended in the hospital until the epidemic was at an end.

Death No. 2, was a woman, aged fifty-seven, with extreme jaundice. She had a

mass extending across the upper abdomen and the diagnosis was in some doubt. The operation was exploratory in character. The mass was found to be an acutely inflamed pancreas and there was an extremely thickened gall-bladder which was simply drained with the hope of helping the pancreatitis. She did well for four or five days; then began to weaken and died of exhaustion thirty-one days after the operation.

Death No. 3 suffered from an acute empyema of the gall-bladder with many stones in its cavity, and she had a septic temperature, the operation being undertaken because she was rapidly losing ground. The cystic duct was so brittle that it broke off when I manipulated the gall-bladder before deciding what was the best procedure. The hemorrhage was extreme and so much trouble was experienced in trying to secure the bleeding artery that I was forced to pack the wound to control hemorrhage. She did fairly well until seven days later, when the packing was removed. The removal was followed by a severe hemorrhage of which she died immediately.

Death No. 4 was Mrs. N. F. H., age seventy-two, very weak from long-continued sepsis due to an empyema of the gall-bladder which also contained stones. Cholecystostomy was done in this case, the operation being carried out as rapidly and gently as possible. She did splendidly for thirteen days and had begun sitting up when she died suddenly of what was pronounced an acute cardiac condition, though no autopsy was permitted.

Death No. 5. Mrs. N. K., aged fifty-eight. This was a case of cholelithiasis with dense adhesions of the gall-bladder to the stomach and hepatic flexure of the colon. There were some difficulties in the operation, and the raw surfaces where adhesions had been loosened were inclined to ooze so that two cigarette drains were introduced. She died of general peritonitis seven days after the operation. The autopsy showed everything intact about the stump of the cystic duct and the liver surface. The area over the hepatic flexure from which the adherent gall-bladder had been loosened was gangrenous, and this was regarded as the source of the peritoneal infection. Looking backward upon this case the question naturally arises, if I had contented myself with a cholecystostomy instead of a cholecystectomy would this woman have recovered? Many times adhesions equally firm have been loosened with no untoward result and there seemed no reason to expect disaster here. Again was it an error to introduce the cigarette drains and may not their presence have caused the necrosis?

Death No. 6. A man, aged sixty, had been losing flesh and strength for several months and was considered an uncertain surgical risk, but he was getting progressively worse and was suffering much distress from a subacute cholecystitis. Cholecystectomy and appendectomy were accomplished easily and there was no shock. Patient did fairly well for the first thirty hours and then died of a heart condition which was attributed by the doctors who observed him as a thrombosis of the coronary artery. As there was no autopsy this point can never be definitely decided.

Summarizing these six deaths, one died of septic peritonitis during an epidemic of streptococcic sore throat; the second from exhaustion thirty-one days after a drainage operation on a woman much jaundiced and with acute pancreatitis; the third, empyema of the gall-bladder, the one in which the cystic duct and artery snapped off and who died of hemorrhage when the pack was removed; the fourth, also empyema of the gall-bladder, which was simply drained, did well, was sitting up and succumbed to a cardiac death thirteen days after operation; the fifth, who died of general peritonitis, resulting from gangrene of the hepatic colon from which the gall-bladder had been dissected; the sixth a rather frail man who apparently died of a coronary thrombosis forty-eight hours after a simple cholecystectomy and appendectomy.

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Looking back on these six deaths, it is easy to criticize. My mind is perfectly easy concerning the first, second, fourth and sixth. Had I been content to simply drain the third case the disaster of breaking off the cystic duct and artery and the later death from hemorrhage might have been avoided, but my experience of reoperating such cases, for their symptoms nearly always continue or return when the condition is so serious, has been such that I think anything short of cholecystectomy does not cure permanently. For this reason my gall-bladder surgery only seldom stops short of elimination of the viscus. The fifth case, the one of gangrene of the colon, is open to discussion.

Analysis of the End Results.—Of the 154 cases that recovered from the operation, to all of whom a questionnaire was sent, answers were received from 144, and many of these were seen and personally examined. Our connotation of the end results will therefore perforce have to be based on the 144 on whose condition we have information.

In order that we may have a common understanding of the results, let it be understood that I am classifying the end results as follows:

1. Cured, if there are left no symptoms to remind the patient of his old trouble.
2. Relatively cured, if the patient is relieved of all the more disagreeable symptoms, but is occasionally reminded of his former trouble by belching or fulness of the stomach.
3. Improved, when there are still disagreeable symptoms, but they are definitely less than before the operation.
4. Not improved, if patient reports himself as no better than before, or if, on examination it is found his symptoms have not been improved.

A glance at the following table will show the results gleaned from the answers to the questionnaire:

Number of answers received	144
Number of cures	100, or 69.4 per cent.
Number of relative cures	31, or 21.5 per cent.
Number improved	7, or 4.9 per cent.
Number unimproved	6, or 4.2 per cent.

There has been a question whether the cases with gall-stones do not offer a better prognosis than when gall-bladder infection is present without stone. So small a series does not mean much, but it is offered for what it is worth:

Number cases of cholelithiasis	69
Number cures	55, or 79.7 per cent.
Number relative cures	10, or 14.5 per cent.
Number improved	3, or 4.3 per cent.
Number unimproved	1, or 1.5 per cent.
Number cases of cholecystitis	75
Number cures	45, or 60 per cent.
Number relative cures	21, or 28 per cent.
Number improved	4, or 5.3 per cent.
Number unimproved	5, or 6.7 per cent.

To those critically inclined I suppose too large a proportion of the operations are for cases of cholecystitis and I am inclined to agree with such a criticism. The fact that the percentage of cures of the cases of cholelithiasis is 79.7 and of the cases of cholecystitis only 60 per cent. gives food for thought. Am positive that a definite inflammation of the gall-bladder existed in all the cases classified as cholecystitis and all were verified by the pathologist; but the question in my mind is, was other pathology responsible for the symptoms in some of the cases? Neurological conditions may account for some of the incomplete cures. It is very manifest that no diagnostic aid should be omitted in order to avoid unnecessary operations when the gall-bladder is under suspicion.

Now we are reaching the main object of this paper, which is to find an answer to two questions: (1) How may the operative mortality of gall-bladder operations be still further reduced? (2) What pathology prevents complete cure, and can the type of operation improve the end results?

A low mortality depends much on the selection of the proper time for operating and a careful preparation of the patient for the ordeal. Let it be understood here that there is no contempt too great for the surgeon who refuses operation on the very ill patient because he is afraid it will increase his mortality. The very ill, the desperately ill, must be cared for, but he must not be operated until the ultimate has been accomplished in preparing him for the operation.

At the present time no surgeon with proper regard for his patient would think of an operation until the case has been studied from all standpoints, the more important bodily functions estimated, and the patient put into the best possible condition. This means a careful diagnosis not only of the gall-bladder itself, but of the patient as a whole. The gall-bladder function and the kidney function must be studied, the condition of the heart and lungs must receive due attention, an intimate knowledge of the arterial system, including the blood-pressure and a careful estimation of the coagulability of the blood must be included as a pre-operative routine.

The diagnostic methods have been greatly improved in recent years. In cases of doubtful diagnosis we have in the Graham-Cole test and the Van den Bergh test definite aids which should always be made use of. Cholecystography, as we make more and more use of it, has been steadily increasing in value as we learn better how to interpret its findings. With experience it is possible to learn more and more the ability of each gall-bladder under inspection to concentrate bile and to estimate its elasticity as revealed by its power to empty after the ingestion of a fat meal. Besides this the shape and size of the viscus is well shown by the Graham-Cole test, its contour being affected by a difference in the elasticity of the different segments of its walls, or by distortions due to adhesions to neighborhood viscera.

The more the Van den Bergh test is used and the more carefully its findings are analyzed, the more evidence is gained for it, especially in borderline cases and in those with complications. Repeated tests are necessary to

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avoid falling into error. It not only measures the degree of jaundice, but by its variation from day to day it is a reliable indicator of the progress of the disease and aids materially in helping to estimate the jaundiced individual's status as a surgical risk. An increasing amount of bilirubin in the blood indicates that operation at this time would be extrahazardous; while definite lessening of the bilirubin indicates a more favorable time for operative intervention even before the jaundice has begun to fade.

For a long time it has been apparent that if accurate knowledge of the condition of the liver could be determined, it would give the surgeon a means of estimating the tolerance of the patient to surgical trauma and would also furnish a better basis for determining beforehand the degree of relief that might be expected from a cholecystectomy.

Unfortunately the many and varied functions of the liver are so little understood and the many suggested tests for these functions so inadequate that thus far they have been of very little practical benefit. Our meagre knowledge of the real functions of the liver and the extreme doubt of the trustworthiness of the proposed functional tests make a pre-operative evaluation of the condition of the liver a matter of grave uncertainty.

As McVicar says, "The liver is a complex workshop housed with many activities." Any of the tests, even if correctly interpreted, gives information only of a single function. If that function is found to be normal, other equally important functions may be out of commission. Let liver function be studied as much as possible, because of valuable knowledge it may lead to, but to follow blindly these tests as a guide to gall-bladder operations will only invite disaster and involve one in uncertainty.

Before operating on the very ill subject of gall-bladder disease a kidney functional test and a careful computation of blood urea-nitrogen will furnish the means of preventing some mortalities. A careful study of the integrity of the heart muscle is also very important.

In preparing the patient for operation, it is most essential that the tissues be most generously supplied with fluids for at least two days beforehand. Much glucose per oram and by the Murphy drip before and after these operations has saved many lives. After operation on a depressed patient a few hundred c.c. of 10 per cent. glucose intravenously is a favorite remedy in my hospital service. It is a cardinal principal to fear dehydration as one would fear the plague and every safeguard is made use of to avoid such a calamity.

The anæsthetic is a question of much importance. Ether anæsthesia, if the patient's condition is good, may be administered, using the minimum amount necessary to affect good anæsthesia. If the patient is much depressed, local anæsthesia is much preferred. A favorite method is to use a local anæsthetic for opening the abdomen and then a few whiffs of gas while completing the intra-abdominal part of the operation, the gas administration being stopped as soon as the gall-bladder is out.

It is my opinion that post-operative shock, morbidity, mortality and end results may all be greatly improved by systematic and extreme gentleness in handling tissues during the operative procedure. The use of local anaesthesia is the best method I know of to train surgeon in art of gentle operating.

Perfect hæmostasis has become such a watchword among modern surgeons that it is scarcely necessary to mention it at this time. Every drop of blood possible to be saved for the patient during the operation should be saved. Intra-peritoneal oozing after the operation is over is calamitous for two reasons: it weakens the patient and it is a fruitful cause of post-operative adhesions and thus prevents complete cures.

It is my conviction that post-operative adhesions are more responsible than any other factor in leaving these patients only partially cured. The most glaring fault in gall-bladder surgery in the past has been the reckless use of gauze and cigarette drains. Every drainage case, if the drainage is unnecessary spells needless adhesions, the adhesions being directly proportional in volume to the volume of the drain. Do not misunderstand my position. I do not go so far as to say that these gall-bladder cases should never be drained, for occasionally in spite of all we can do, there is still some oozing from the liver surface, or there may be some other complication that makes it desirable to drain, but in the average case the wound may be closed without drainage with perfect safety and when this is done the immediate convalescence is smoother and shorter and the end results better.

Other things being equal the longer gall-bladder disease has been present the more neighborhood pathology will be found. First and foremost the liver suffers from pathology secondary to gall-bladder infection. Seldom, as Graham has so clearly pointed out, do we find a diseased gall-bladder without hepatitis. The liver is notoriously able to repair itself, but many of these old cases of cholecystitis show a liver with so much deposit of fibrous tissue that it would be unreasonable to expect it to become wholly normal, even after the source of its pathology, the gall-bladder, has been removed.

Many gall-bladder infections are accompanied by cholangitis, even the smaller biliary ducts are so distorted by inflammation that they can never be expected to become normal. Unquestionably unrelievable liver pathology is the cause of many of the cases of gall-bladder surgery being followed by incomplete cures.

The pancreas is another organ that is early affected by infection of the gall-bladder. Pancreatitis of less or greater degree of severity is an almost constant complication of cholecystitis. If the gall-bladder is removed early before irremediable changes in the pancreas have occurred, the more chance will there be that all disagreeable symptoms will disappear.

Some striking experiences have profoundly impressed me that all the train of rheumatic symptoms attributed to focal infections in general are derived from the infected gall-bladder more frequently than generally supposed. Several personal experiences bear out this belief; cases with rheumatic pains, valvular heart lesions and all the other dire consequences of

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infection: who have had their tonsils removed, their teeth extracted, their sinuses drained with no benefit, have cleared up promptly after removal of an infected gall-bladder.

In conclusion it seems reasonable to believe that with increasing knowledge in selecting the time for surgical intervention, increasing experience in operating, a fuller appreciation of the value of gentleness in manipulation of tissue, and a more general appreciation on the part of the profession in general that an infected gall-bladder produces complicating pathology in direct ratio to the time it is allowed to spread infection, will do much not only in reducing the operative mortality, but will greatly increase the proportion of cases completely cured.

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REMARKS FOUNDED UPON A STUDY OF TWELVE CASES

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DIVERTICULUM of the urinary bladder has ceased to be a rare finding as a result of the more universal application of cystoscopy and cystography in lesions of the lower urinary tract. This improvement in the diagnosis has shown diverticula to be present in from five to seven per cent. of cases seen during the prostatic age. Trabeculae and small saccules are frequently seen in cases presenting obstructive symptoms, whereas the diagnosis of true diverticulum of the bladder is limited to those cases possessing a distinct orifice with herniation of the entire bladder wall and excludes such anomalous conditions as urachal cysts, hour-glass bladder, etc.

Much contention has existed in the past as to the cause of diverticula. The early writers attempted to classify diverticula as true and false, depending on whether or not the sac contained muscle fibres, but the work of Rose and others has shown that this attempted classification is erroneous. It is now generally agreed that diverticula have both congenital and acquired factors for their development. Recently Hyman collected a series of thirty cases of diverticulum in children. Three of these were his own and presented no demonstrable obstruction to the outflow of urine. Judd, Young, Watson, Hyman, Gardner, Crosbie, and Rose are of the opinion that congenital factors play an important rôle in the development of diverticula. The fact that diverticula are often seen in children and occasionally found in the fetus, and in females with no apparent urinary obstruction, as was found in one case in this report, shows that there is a congenital predisposition to such formation. LeComte reported a case of true diverticulum in a young man with no obstruction present. The acquired factor depends on urinary obstruction for its development and is usually seen during the prostatic age. The fact that diverticula are seen more frequently in men shows that prostatic obstruction is one of the principle acquired causes. Judd says diverticula are rare in females, having seen but two cases in a large series from the Mayo Clinic. Pugh in a recent report of one hundred collected cases found twenty-five per cent. were under forty years of age.

Location.—The most common site for diverticula is at the upper and lateral margin of the trigone, especially in the region of the ureteral orifice. Occasionally the ureter becomes incorporated in the wall of the sac. Frequently in cystoscopy a prostatic we see multiple cellules of varying depths, as well as marked trabeculation of the bladder as a result of back pressure. Unless

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the obstruction is removed these cellules often herniate through the bladder wall and result in diverticula. As long as drainage is adequate and infection is absent the diverticulum is of no clinical importance. Residual urine accumulates as a result of obstruction, and sooner or later produces urinary disfunction as well as renal insufficiency.

Symptoms.—There are no symptoms pathognomonic of vesical diverticula.

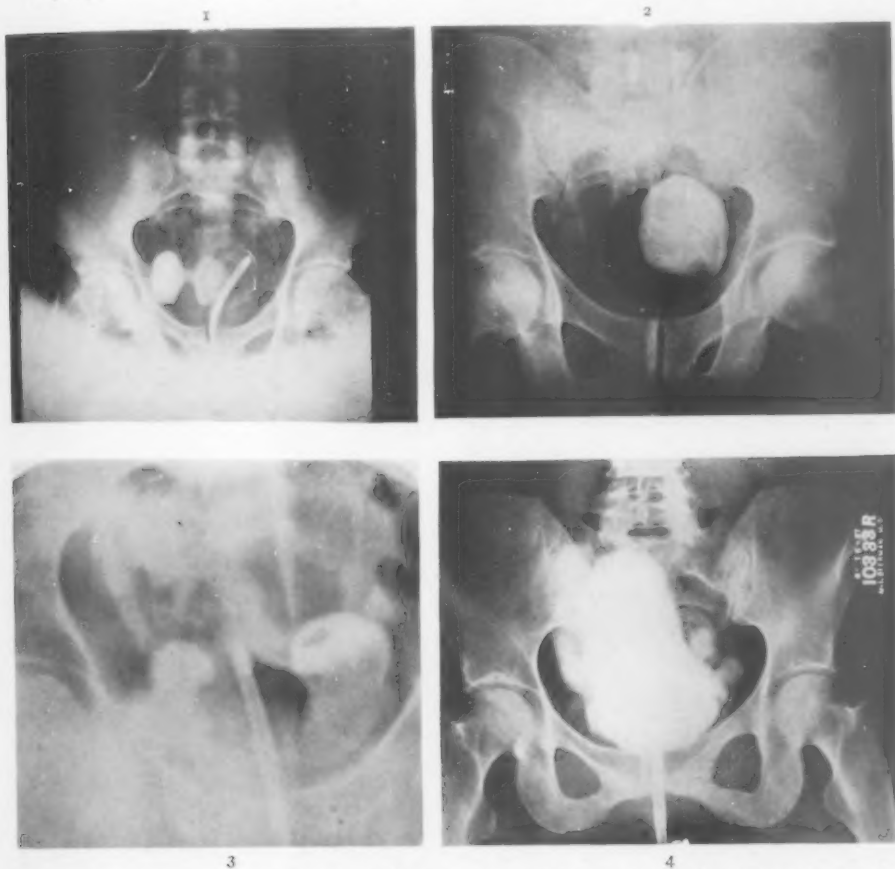


FIG. 1.—Recurrent dumbbell stone in bladder and associated diverticulum. Stone removed and diverticulum resected.

FIG. 2.—Contract cystogram showing diverticulum filled with opaque solution. Catheter in bladder. Black shadow shows air in bladder. This method shows the inability of such a diverticulum to empty.

FIG. 3.—A contrast cystogram showing the presence of two diverticula. The bladder was filled with air subsequent to the injection of sodium iodide solution.

FIG. 4.—Cystogram of adult female with urethral stricture. The diverticulum and associated cellules held thirty-two ounces of solution.

However, the patient frequently complains of inability to completely empty the bladder, *i.e.*, ability to pass an additional quantity of urine after the bladder is thought to have been emptied. As the majority of diverticula are seen during the prostatic age, the symptoms are those of obstruction to the outlet of the bladder. Frequency of urination, together with inability to completely empty the bladder and the passage of foul urine, constitute the most common symptoms of this condition. Three patients in this series were able to pass an additional quantity of urine after the bladder was

thought to have emptied. Ten of the patients had foul, cloudy urine and complained of some difficulty and pain on voiding as a result of the cystitis. Often the symptoms of benign prostatism overshadow those of diverticulum

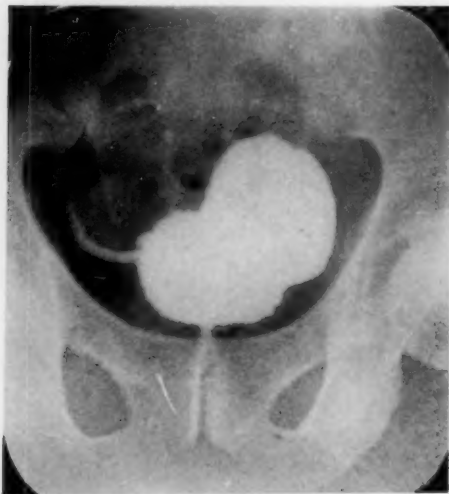


FIG. 5.—A large vesical diverticulum distended with sodium iodide solution. Note contrast in smooth contour of diverticulum compared to rough irregular bladder outline. Some regurgitation of fluid may be seen in right ureter.

Gardner reports three cases of benign prostatism in which a diverticulum was overlooked at the time of operation. A plain urogram should always precede any operative procedure on the urinary tract. This precludes the possibility of overlooking a stone in the ureter, kidney, or in a blind diverticulum as was done elsewhere in one case herein reported. The cystoscopic findings should always be corroborated by cystography, as the latter is more accurate in determining the exact size, and whether or not the diverticulum empties completely. One should not rely on the cystoscopic diagnosis alone, as the size of the diverticular orifice is no criterion as to the capacity of the sac. A series of three or more plates should be made in doing a cystogram, consisting of an antero-posterior view, a lateral view to show the retrovesical type, and one after the bladder is emptied to see if retention in the sac occurs. A contrast cystogram filling the bladder with air after draining the sodium iodide solution aids in the diagnosis. It is often impossible to estimate the position of a retrovesical sac from an antero-posterior radiogram. A

so that the patient is frequently unaware of the presence of a diverticulum. Hæmaturia is occasionally seen as an accompanying symptom, especially in the presence of a new growth.

Diagnosis.—Cystoscopy in competent hands affords a very accurate method of determining the presence of a diverticulum. The size, number, location, and relation to the ureteral orifice can usually be ascertained by this method. While in some cases of prostatic obstruction cystoscopy is contra-indicated, it is very necessary to determine whether or not calculi and diverticula are present before one is warranted in proceeding with a prostatectomy.



FIG. 6.—An unusual type of vesical diverticulum with both ureteral orifices emptying into it. Both ureters markedly dilated. No obstruction could be demonstrated.

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five per cent. solution of sodium iodide is an excellent medium for outlining the sac by cystography. Stone is occasionally seen in a diverticulum and may be entirely overlooked by cystoscopy if the calculus is located in the sac alone. One case in this series had a dumbbell stone situated both in the bladder and diverticulum, which had been overlooked at cystoscopy elsewhere, and the patient made worse following an operation by another surgeon, because he was not radiographed. A point that we wish to emphasize at this time in the diagnosis of this condition is the value of an opaque catheter coiled up in the diverticulum as well as a lead catheter

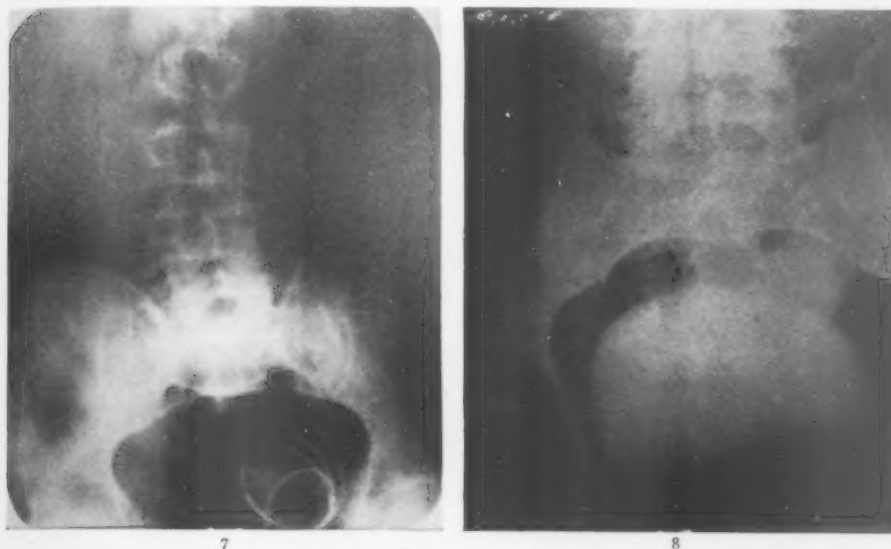


FIG. 7.—Stereoptic plates with opaque catheter coiled in diverticulum, a second in the ureter. By this method one is able to determine the relationship of a diverticulum to the affected ureter.
FIG. 8.—Large vesical diverticulum seen in antero-posterior view.

in the ureter on the affected side. This enables one to form a definite idea as to whether or not the ureter is incorporated in the diverticulum. It also serves as a guide in removing an adherent diverticulum which is adjacent but not included with the ureter.

Treatment.—Hunt says that a diverticulum of an ounce or more capacity with retention and inadequate drainage should be treated surgically. Diverticulum is of no clinical importance as long as infection and residual urine are not present. If the orifice of the diverticulum is large, and the sac so situated that retention does not take place, palliative measures may be tried. Read has suggested division of the constricting ring at the orifice in those cases where resection is not advisable. He says that this affords better drainage of the sac. In the presence of residual urine and infection it is imperative that the diverticulum be resected in order to get good functional results following prostatectomy. No particular method of removal can be used in the different types of diverticula. Intravesical removal of small diverticula is quite feasible as suggested by Young. However, where a large

sac is present, it can best be removed by extra-vesical resection. Lower advises packing the sac with gauze before resection is attempted. This converts the sac into a solid tumor which facilitates removal. The method of removal which we have most frequently practiced is the following: After the bladder has been opened, a finger is introduced into the diverticulum and traction applied from within the sac. This facilitates separation of the sac from the rather loosely attached surrounding structures. Blunt dissection is carried down to the neck of the sac, which is then divided and removed. The bladder opening is closed with a Pezzar catheter in the suprapubic incision. A rubber tissue drain is inserted to the site of the sac.

If the ureteral orifice is incorporated in the diverticulum, transplantation of the ureter to another portion of

the bladder may be done. Herbst says many of the cases with poor functional results following prostatectomy are due to diverticula being overlooked at the time of operation.

Associated Lesions.—The presence of residual urine in a diverticulum with subsequent infection readily lends itself to the production of calculi. Two cases in this group had large vesical calculi present, one being dumbbell in type which had



FIG. 9.—A large vesical calculus associated with multiple diverticulæ and benign adenoma of the prostate.

reformed from a calculus located in an accompanying diverticulum. Fifteen per cent. of the cases reported by Judd and Scholl had stone as an accompanying factor. Nine of these stones were found in the diverticulum alone. New growths may occasionally be seen in the presence of diverticulum as occurred in one case in this group. The literature shows an increasing number of cases in which carcinoma was found associated with a diverticulum. A plain X-ray should be taken in all cases in order to rule out metastasis. This may prevent an unnecessary operation.

Summary of Cases.—Six of these cases presented unusual features. The first, a relatively rare dumbbell type stone in bladder and diverticulum; second, a diverticulum of the bladder associated with a diverticulum of the ureter; third, an enormous diverticulum with eight associated diverticula present which held thirty-two ounces; fourth, a large diverticulum of the bladder of a female without obstruction; fifth, a diverticulum of the bladder with both ureteral orifices opening in it, associated with enormous hydro-ureters and hydronephrosis; sixth, a large vesical calculus associated with two diverticula of the bladder. Seven of the twelve cases were operated on successfully; three cases being inoperable as a result of cardio-renal disease; the remaining two had palliative treatment.

One of the most striking observations of this study was the relative proportion of females to males. Four of these cases occurred in females.

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The last four cases were seen during the past two weeks, two being seen the same morning. Of the last three cases, two were females and neither had any symptoms referable to the urinary tract, showing that diverticulum may exist without the patient being aware of its presence. Lack of time precludes the possibility of reporting all twelve cases; however, seven have been selected that represent the various types of case.

ILLUSTRATION OF CASES

CASE I.—J. C. K., male adult, aged sixty-three, was first seen June 7, 1925. Chief complaint was difficulty and pain on urination, together with nocturia. Past history, essentially negative. Patient has been having disturbance of urination for the past three years, gradually increasing in severity until at the present time he finds it necessary to arise from three to six times during the night to void. Rectal examination shows moderate prostatic enlargement. Cystoscopic examination showed marked trabeculation together with a diverticular opening situated lateral and superior to the right ureteral orifice. Some intra-vesical protrusion of the prostate was noted. An opaque catheter was coiled in the diverticula which measured four cm. in diameter. The patient was decompressed with an indwelling catheter for ten days after admission to the hospital. The diverticulum was then resected by intra-vesical inversion after the method of Young, the neck ligated and the opening closed with catgut. A relatively small prostate was also removed at this time. Convalescence was uninterrupted, and the patient discharged five weeks later, cured. Subsequent history normal.

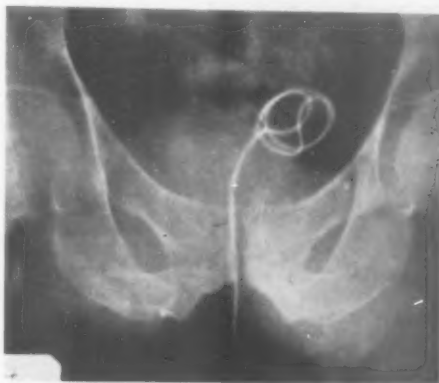


FIG. 10.—Opaque catheter in diverticulum which was found associated with the vesical calculus.

CASE II.—Mr. C. L. N., white, male adult, age sixty-five, referred by Doctor Davies of this city. Entered hospital, June, 1925, complaining of intense tenesmus, frequency of urination, and hæmaturia. Past history, negative. No serious illness until 1915 when frequency of urination and hæmaturia were noticed. The urinary symptoms gradually increased in severity, especially when the patient was on his feet. The pain, dysuria, and the presence of blood in the urine caused him to seek medical attention. On May 20, 1918, a cystoscopy was done elsewhere and the diagnosis made of stone in the bladder. A suprapubic cystotomy was done by a local surgeon and the stone removed. Following this operation the patient was unable to void and had been catheterized for the past seven years. His former symptoms returned, and a second cystoscopy was done by another urologist. Patient was advised to have an operation but refused. We saw the patient May 2, 1925, for the first time. He was in severe pain, requiring morphia for relief. Vesical tenesmus was most marked and he complained of inability to empty the bladder. A plain X-ray showed a large dumbbell stone in the bladder and connecting diverticulum. The patient refused a cystoscopic examination. He was advised to have the diverticulum and stone removed, which was done. The two stones were united and it was necessary to fracture the junction in order to remove each half. The diverticulum was then resected. There was no demonstrable enlargement of the prostate. This case supports the congenital theory of diverticular formation as the patient had no prostatic enlargement. He had had the diverticulum over a period of ten years or more. The

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reformation of the stone which apparently had not been recognized as a dumbbell one at the first operation, was the cause of the return of symptoms.

CASE III.—Mrs. Mary B., colored, female, age sixty-six, first seen November 10, 1925. Chief complaint, difficulty and pain on urination. Past history, irrelevant to present complaint. Patient has been having difficulty in voiding for the past ten years. The symptoms were intermittent in character. No blood or stone had been noticed. The difficulty in urinating had become so pronounced that she came to the hospital for relief. Cystoscopic examination showed a large diverticulum situated lateral and slightly superior to the right ureteral orifice. The diverticular opening was so large that a cystoscope could be passed in to the diverticulum. The capacity was equal to that of the bladder. The urine was very foul and turbid. A cystogram was not done due to the marked infection and poor condition of the patient. Physical examination showed a marked toxic myocarditis with irregularity of the pulse, probably as a result of the long-standing infection. No operative relief was suggested due to the cardiac condition and after daily bladder lavages much improvement was seen. The patient left the hospital at her own

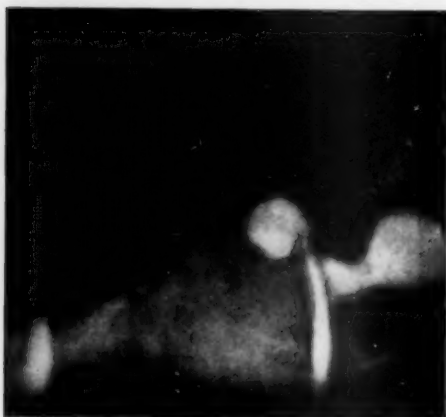


FIG. 11.—Lateral cystogram showing an almost hour-glass type of diverticulum. This diverticulum could not be demonstrated antero-posteriorly, but shows the value of a lateral plate.

request and was told to return at intervals for treatment. She died several months later, probably as a result of the urosepsis. No obstruction was found present in this case, the urethral lumen being normal. This case shows that diverticulum may be occasionally seen in the complete absence of urinary obstruction and was probably congenital in origin.

CASE IV.—Mrs. E. B. D., white, female adult, age fifty-five, referred by Dr. Harry Bernton. Chief complaint, extreme dysuria, inability to empty bladder, together with cardiac failure. Past history irrelevant. Patient has been having pain on urination for the past twenty years, beginning at the birth of her last child. The urinary symptoms became aggravated on exertion and for the past five years resulted in almost continuous pain in the bladder region. Shortness of breath and cardiac decompensation occurred probably as a result of urinary sepsis. Urinary examination revealed the presence of an almost impassable urethral stricture. This was gradually dilated and irrigation of the bladder caused a marked amelioration of her symptoms. Cystoscopic examination showed an enormous diverticulum of the bladder with smaller sacs incorporated in the larger one. A cystogram was done and demonstrated the upper margin of the diverticulum on a level with the brim of the pelvis. The bladder and sac held thirty-two ounces of very foul turbid urine. There has been very marked improvement in the cardio-vascular condition with no shortness of breath and she has been able to resume her normal activities. Resection of the sac has been suggested, but in view of her improvement it has been deferred to a later date.

CASE V.—Mr. Joel J., male adult, age eighty-seven, was seen July, 1926, in consultation with Dr. Louis Mackall. Chief complaint was difficulty in voiding and hæmaturia. Patient gave a history of falling astride a buggy wheel sixty-five years ago, rupturing the urethra at the peno-scrotal junction. An attempt at catheterization resulted in false passage. An external urethrotomy was done and a tube left in the urethra for several weeks. This was followed by a permanent urinary fistula which would only admit a child cystoscope. The urine was bloody and very foul. A diagnosis was made of carcinoma of the bladder. Under local anæsthesia the bladder was opened and the tumor

DIVERTICULA OF THE BLADDER

found incorporated in the orifice of a diverticulum located lateral to the left ureteral orifice. The tumor was destroyed by the radio knife and the constricting ring of the diverticulum divided. Convalescence was uneventful. An X-ray study revealed metastasis in the pelvic bones, which resulted in his death three months later. Resection in this case was obviously contra-indicated due to the metastasis.

CASE VI.—Mr. S. L., white, male, adult, age sixty-six, seen July, 1927, in consultation with Doctor Carrico. Past history was negative. Chief complaint, difficulty in starting and stopping urination with nocturia. For the past five years patient has had to get up five or six times at night to void. This was accompanied by pain and the passage of but small quantities of turbid urine. Rectal examination revealed a moderately enlarged prostate. Cystoscopic examination showed a larger diverticulum lateral and slightly superior to the right ureteral orifice. An opaque catheter was coiled in the sac and another catheter inserted in the right ureter, followed by stereoscopic plates. This was done in view of the intimate connection of the diverticulum and right ureteral orifice. The X-ray study showed the ureter to be several millimetres anterior to the sac. A cystogram was made and showed the diverticulum to be larger than the bladder. The prostate was enlarged intravesically. The diverticulum was resected extravesically at the first operation, followed by a prostatectomy two weeks later. Recovery was uninterrupted and the patient has been seen at frequent intervals and is free from residual urine, nor has he had any return of his former symptoms.

CASE VII.—Mr. W. M. L., white, male adult, age forty-eight, seen June 15, 1927, in consultation with Doctor Meyers. Chief complaint, pain in suprapubic region with some difficulty in voiding, plus haematuria. For the past year has noticed that when he is on his feet the pain is increased, as well as the bleeding. Gets up from one to three times at night to void, with occasional sudden stoppage of urinary stream. The urine is also blood-tinged after long rides in automobile or when riding horse-back. Patient says urine has been very cloudy for past two or three years with a rather foul odor. A plain X-ray shows a large oval calculus in the bladder area. A rectal examination shows no appreciable enlargement of the prostate gland. Patient refused to be cystoscoped. Physical examination shows a robust, well-developed man of low mentality. Kidney excretion and retention test normal after ten days drainage of bladder with an indwelling catheter. This was followed by suprapubic cystotomy under ethylene. The large stone was removed and two diverticular orifices located lateral and inferior to each ureteral orifice. The orifices were large enough to admit a small finger. A cystogram made several days later showed a large diverticulum almost hour-glass in character. This was resected after the method described by Geraghty. Convalescence normal.

SUMMARY

1. Diverticulum of the bladder occurs in from five to seven per cent. of patients reaching the prostatic age.
2. Congenital factors play an important rôle in the etiology of these cases. Obstruction at the bladder outlet converts these potential hernias into a true diverticulum.
3. In the presence of residual urine and infection, resection offers a good prognosis in operable cases. The obstruction should be removed at a subsequent operation.
4. Cystoscopy in conjunction with serial cystograms affords a very accurate method of diagnosis and should be practiced in prostatics unless definite contra-indications exist.

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CONGENITAL HYPERTROPHY OF THE INTERURETERAL RIDGE

BY STANISLAW LASKOWNICKI, M.D.

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FROM THE INTERNAL CLINIC (DIRECTOR, PROF. DR. RENCKI), AND FROM THE SURGICAL CLINIC (DIRECTOR, PROF. DR. H. SCHRAMM) OF THE JOHN CASIMIR UNIVERSITY OF LWÓW

THE publications of Wesson and Young on anatomy and physiology of the trigone of the bladder attracted the surgeons' attention to a new type of disease defined as Hypertrophy of the Interureteral Ridge which leads to urinary disturbances and sometimes results in complete obstruction of urination.

The etiology of this disease has not been sufficiently explained as yet. All cases of this rare disease described hitherto concerned people of middle or old age (Blanc's youngest patient was 39 years old), and in most of these cases the anamnesis showed that the patients were affected with gonorrhœa some time before. Accordingly, Hinman and Wesson supposed that the most likely cause of the hypertrophy of the interureteral ridge is a long continued mild obstruction caused by a small fibrous contracture of the vesical neck, secondary to many attacks of gonorrhœa, or that this disease is brought about by continued irritation of the bladder resulting from a chronic inflammatory state of the posterior urethra of the vesical neck or the bladder itself (tuberculosis). These writers suppose that this pathological state can be congenital, they add, however, that a case of congenital hypertrophy of the interureteral ridge has not, so far, been observed by anybody.

However, recently I had occasion to observe a case of hypertrophy of the interureteral ridge where the fact of its being congenital seemed to be beyond doubt.

No. 216 1925/26.—Ph., male, aged twenty-five, was never affected with any venereal disease. At the age of twenty-two he had pneumonia, and since that time at the least effort he felt stinging pain in the right side of the thorax. For the last six months he felt continually very thirsty, for the last four months he suffered from frequent micturition, as well as pain and burning during urination.

He urinated frequently with difficulty in small quantities. In the last few weeks the urination became more troublesome. During daytime he urinated every 15–20 minutes, and at night 12 to 14 times.

The examination showed: The patient was of middle height, well-built, well-nourished, the skin of normal color, the temperature was normal. The lungs, the heart and the digestive tractus normal. The lower poles of the kidneys were distinctly palpable. The left kidney was sensible to pressure. In the lower part of the abdomen a swelling from the pubic symphysis up to the navel could be felt. No changes in the central nervous system were observed. On the day of admission the urine was quite normal, excepting low specific weight (1003).

The patient remained at the clinic for internal diseases for ten days, where he was catheterized twice a day, and every time 2500 to 3000 cubic centimetres of urine were evacuated. The quantity of urine emitted within twenty-four hours amounted to 5000 cubic centimetres. A short time after the symptoms of infection of the bladder appeared,

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the temperature increased, and the urine became troubled. The patient was sent for examination and further treatment to the surgical clinic.

The cystoscopy showed: The neck of the bladder and the trigone were lifted up considerably and were covered with *œdema bullosum*. The orifice of the ureter and of the vesical neck could be seen within one sight-field (Marion's symptom). The bladder wall was trabeculated, above both orifices of the ureter two openings of two diverticula were seen, the mucous membrane of the bladder inflammatorily changed, also numerous

pieces of fibrin were seen. The interureteral ridge was distinctly prominent and thickened, with a deep pouch behind, the bottom of which could not be seen. The prostate was not enlarged, of a soft consistency, and in one place in the left lobe a little hardened.

After the catheter was put into the bladder, the urine flowed out in a strong stream which could be intensified by the patient. The examination of the blood showed 110 milligrams of nitrogen in 100 cubic centimetres.

The diagnosis involved mechanical obstruction of urination. On account of some topographical changes (Marion's symptom), *i.e.*, on account of the vesical neck being drawn nearer to the orifices of the ureters, as well as because of the trigone being con-



FIG. 1.—Showing changes in wall of bladder, ureters and kidneys.

considerably lifted up, it was suspected that there was a sarcoma of the prostate growing into the bladder (*œdema bullosum*). The hypertrophy of the interureteral ridge, the existence of the diverticula and the obstruction of urination we explained with changes which we supposed had taken place in the prostate.

The patient was catheterized every morning, and the bladder rinsed with a solution of 1:1000 *argentum nitricum*, after which the patient did not urinate the whole day, in the evening only he felt the necessity of urinating, and urinated then (*i.e.*, at night) 10 to 15 times in small quantities.

On December 15, cystoscopy showed the state unchanged. The patient was therefore catheterized twice a day, in the morning and in the evening.

On December 20, the patient left the clinic at his own request.

The patient went to another urological division where the cystostomy was made. Three days after the operation the patient died with symptoms of *uræmia* and of the weakening of the heart.

The post-mortem examination showed:

Status post sectionem altam. Ligamentum interuretericum hypertrophicum. Hypertrophica vesicae urinariae trabecularis. Diverticulum vesicae parietis posterioris lateris dextri (altitudinis 5 centimetr. latitudinis 2 centimetr.) et parietis posterioris lateris sinistri (altid. 0.8 centim., latid. 1.2 centim.). Hydronephrosis ambilateralis. Dilatatio ureterorum ambil. Cystopyelo-nephritis purulenta, chronica, ascendens. Paracystitis

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chronica. Peritonitis fibro-purulenta, diffusa recens. Hypertrophia cordis sinistri et dilatatio cordis dextri. Hyperæmia et œdema pulmonum. Bronchiectasia cylindriciformis et bronchitis muco-purulenta. Degeneratio parenchymatosa hepatis. Tumor lienis septicus.

In Fig. 2 are seen changes which took place in the wall of the bladder, in the ureter and in the kidneys, caused by a long stagnation of urine. The wall is considerably hypertrophied, especially the layer of muscles. The wall of the bladder is trabeculated and cellulated. On the right side above the ureteral orifice was the opening of a diverticulum 5 centimetres deep and 2 centimetres broad, and on the left another diverticulum 0.8 centimetres deep and 1.2 centimetres broad. The recess behind the interureteral ridge was 2.5 centimetres deep, the distance of the interureteral ridge from the back-wall of the bladder being 1.5 centimetres in the middle plane of the bladder.

The hypertrophy of the interureteral ridge was the cause of the complete obstruction to urination. This difficulty in urinating

caused by the above described hypertrophy of the interureteral ridge increased slowly but steadily every day, and resulted finally in complete obstruction of urine and caused ischuria paradoxa. The capacity of the bladder reached at last the enormous quantity of two litres. Constant presence of residual urine in large quantities caused difficult outflow of the urine from the ureters and renal pelvis, it further caused their considerable dilatation which resulted in the atrophy of the renal parenchym and in the insufficiency of both kidneys shown by the number of 110 milligrams, as this was the quantity of the nitrogen in 100 centimetres of blood. A comparatively light operation and subsequent slight infection, which spread in the weakened body, brought in a short time the death of the patient exhausted by the long disease.

The above case is, to my knowledge, the first case described in literature of congenital hypertrophy of the interureteral ridge. In a young man of an athletic body constitution who never had gonorrhœa and who felt sick only when the symptoms of a renal insufficiency appeared, an hypertrophy of the interureteral ridge was ascertained by cystoscopy and post-mortem evidence as the only cause of the obstruction of urination.

So considerable pathological changes, so large ambilateral hydronephrosis, and dilatation of the ureters up to the thickness of an intestine could not possibly arise within several months, but many years were necessary to bring about such changes. The patient probably did not empty his bladder ever since his birth. The capacity of the bladder increased more and more. At

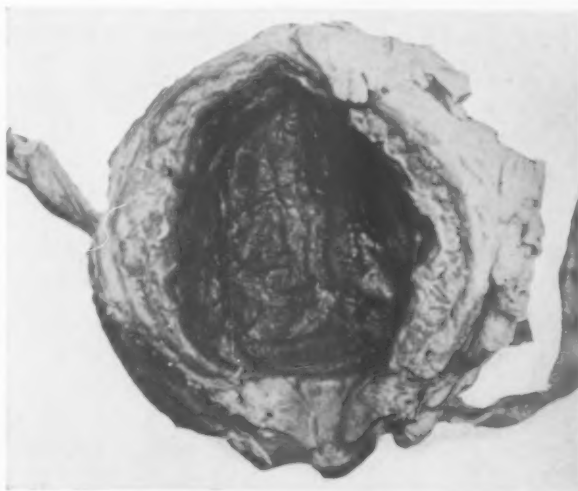


FIG. 2.—Showing the hypertrophied interureteral ridge.

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the same time, on account of frequent contraction of the musculus trigonalis all efforts to empty the bladder of the residual urine being fruitless, the trigonal muscle underwent continuous hypertrophy, which, in its turn, caused the hypertrophy of the interureteral ridge.

The post-mortem examination of the body did not show any other obstacles either in the vesical neck or in the urethra that could cause urine stagnation.

As may be seen in the photograph, Fig. 2, the prostate and the posterior urethra do not show any changes. Nor was there any paralysis of the bladder, as no changes in the nervous system could be observed either in life or after death. The hypertrophied ridge was the only cause why all efforts of the musculus trigonalis to empty the bladder from residual urine remained without effect.

HODGKIN'S DISEASE OF BONES *

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THAT curious pathological entity known as Hodgkin's Disease presents many bizarre pictures that arrest attention from the standpoint of clinical diagnosis. Many pathologists regard it as essentially a disorder of the hemolytotoxic system. As such, they have recognized the frequent involvement of the bone marrow in addition to the lymphoid structures of the body. Just how frequently the bones are affected is difficult to state from an examination of the literature, as they are seldom investigated at necropsy. Ziegler¹ says that the bone marrow is involved in from 30 to 40 per cent. of the cases. Symmers² thinks that it is affected in every case. In rare instances the bones seem to be involved primarily. Hammer,³ in discussing a case of probable Hodgkin's Disease, has suggested that the bone may become involved before the lymph glands. Ziegler in his classification speaks of an osteoperiosteal form of Hodgkin's Disease. In such cases the bone lesions may present a clinical picture resembling either an inflammatory or a neoplastic growth or both, and the diagnosis is most difficult. This assumption of a primary bone involvement is frankly indicated in the following case:

C. K., a white Polish boy, nine years of age, was admitted to the Children's Memorial Hospital on February 25, 1925, because of a lump on the right leg and the neck. He had been well up to about a year before admission, when he was struck on his right leg by a dish bowl thrown by another boy. Two nights later he developed severe pain in the injured region. This pain was present only at night upon going to bed and kept him awake for one or two hours. This continued for a month and during this time no lump or other abnormality was noted.

Two months later a lump appeared on the right leg laterally near the knee. This grew rapidly during the next three days and the skin opposite was red to pink. The lump diminished in size, presumably after poultices, but for the next six months before admission it was of a size similar to that noted when child was admitted to hospital.

Four weeks before admission the lump in the back of the neck was noted. This also grew rapidly but subsided a little before admission. It was not inflamed or painful. There had been a marked loss of body weight. A similar swelling of the neck in the same location had been present three years before admission, but it lasted only for three or four days and disappeared after poulticing. The family and past history was negative.

When examined the first time he was moderately emaciated and anemic. There was a moderate size node under each angle of the jaw. In the back of the neck, mostly on the right side, there was a tumor about the size of a plum, which was deeply seated. There was no evidence of inflammation. The tumor could be moved slightly but seemed to be attached to the spine or base of the skull. Movement of the neck was not restricted and was painless.

An X-ray examination showed a tumor mass involving the spinous process of the

* Read before the Western Surgical Society, December 9, 1927.

second cervical vertebra. (Fig. 1.) There was a large swelling of the right tibia occupying its middle one-third. It was spindle-shaped and raised about 2 cm. at its highest point. It occupied the inner surface of the bone, the sharp edge of the tibia being uninterrupted. There was no tenderness or signs of inflammation. There was no general enlargement of the lymph-nodes found although nodes were palpated in the neck, axillæ and groin. Temperature, 98.6. Pulse, 80.

Operation.—March 20, 1925. Under ether anæsthesia, a cross-bow incision was made



FIG. 1.—Tumor springing from second cervical vertebra spine.

over the cervical region posteriorly. The tumor mass was exposed beneath the neck muscles. It seemed to be encapsulated and could be separated easily except at the spine of the second cervical vertebra from which it was detached with difficulty. Because of excessive bleeding some small portions of the tumor could not be removed from the right side of the neck. The wound was closed in layers with a cigarette drain in the cavity.

Except for some superficial infection, the wound healed satisfactorily and the boy was discharged from the hospital, April 19, 1925.

The tissue removed from the neck appeared to be homogeneous yellow tumor tissue which was very friable and not very vascular. The microscopic report by Doctor Hibbs, the hospital pathologist, was as follows:

Tumor of neck—densely cellular structure, consisting of lymphocytes, endothelial cells, an occasional endothelial giant cell, a few multinucleated cells (Dorothy Reed). The predominat-

ing cell, however, is polymorphonuclear, in huge numbers, many of them fragmented and about equally neutrophilic and eosinophilic. (Fig. 2.) Opinion—eosinophilic lymphogranulomatosis.

The child was readmitted to the hospital on May 25, 1925, about five weeks after his discharge. The tumor mass in the neck had grown again to about the size it was before the operation and the boy complained of considerable pain in his right leg at the site of the swelling.

The röntgenogram of the right tibia (Fig. 3) showed what appeared to be a chronic osteomyelitis. It was decided to explore this bone.

May 29, 1925. Under ether anæsthesia a longitudinal incision was made over the swelling in the right tibia. By chiseling off part of the anterior side of the tibia the

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marrow cavity was exposed. It was filled with a yellowish tumor mass similar to the tumor tissue removed from the neck. The cavity was curetted out down to healthy appearing bone. The skin was then closed over the bone.

The wound healed per primam. The report, by Dr. W. G. Hibbs, of the histological examination of sections of the tissue removed from the right tibia was as follows:

Bone normally canalized, normal content. There is a marked hyperplasia of the periosteum, infiltrating adjacent lymph-nodes, and intimately adjacent to a densely cellular granuloma containing a network of sparse new fibrous tissue. There is a huge number of polymorphonuclear eosinophilic leucocytes, a moderate infiltration of neutrophils, the remaining cells being lymphocytes, endothelial cells, a few multinucleated large cells, (Dorothy Reed) and an occasional endothelial giant cell. Opinion—eosinophilic lymphogranulomatosis involving bone.

Blood examination at the time, showed a leucocytosis of 26,000 with a differential of polymorphonuclear 62 per cent., large mononuclears 6 per cent., small mononuclears 30 per cent. and transitionals 2 per cent. The hæmoglobin estimation was 80 per cent. Red blood-cells 4,200,000.

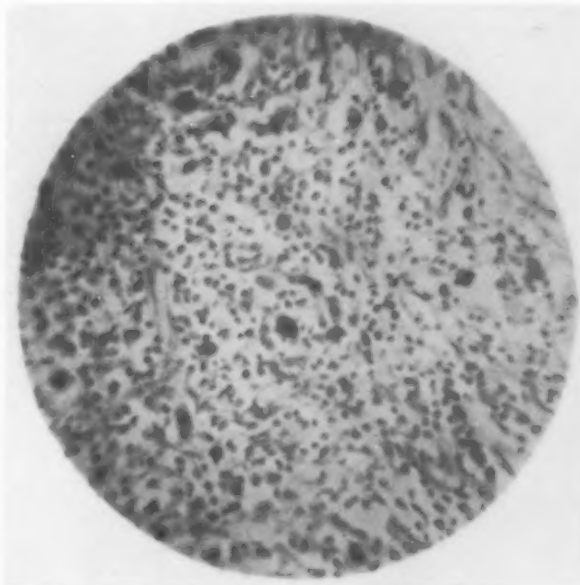


FIG. 2.—Hodgkin's disease of bones.

The boy made a good recovery, so a month later it was deemed advisable to make a second attempt to remove the mass in the back of the neck.

June 26, 1925. Under ether anaesthesia the old operation scar on the back of the neck was removed and the wound opened. The tumor mass, apparently encapsulated, was dissected out thoroughly. The eroded spine of the second cervical vertebra was exposed in the bottom of the wound. The cavity was packed with iodoform gauze and closed with silkworm gut sutures.

The report of Dr. W. G. Hibbs on the histological examination of the tumor tissue removed at this time was as follows:

Lymph-node and granulation tissue, richly vascular, in its border retaining muscle and infiltrated with ramifying cells of adjacent periosteal hyperplasia. In the granulomatous mass there is a moderately profuse infiltration of eosinophilic polymorphonuclear leucocytes, neutrophilic, many of them fragmented, dense focal and diffuse infiltration of endothelial cells, sparse endothelial giant cells, sparse new fibrous tissue, and a moderate number of Dorothy Reed cells. Blood pigment is abundant. (Hemosiderin.)

Five days after this operation radium was inserted into the wound cavity. He was dismissed with a small discharging wound, July 10, 1925.

Four months later he was admitted again. The tumor on the back of his neck had recurred and was now the size of a fist. The tumor on the right tibia had also grown again and was almost as big as a lemon. His physical condition otherwise showed no changes. The tumor masses were not giving him any discomfort. Radium treatments were given as follows:

June 30, 1925, 25 mgs. applied in wound 8 hours.

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November 5, 1925, 3 Blocks 100 mgs. each, applied over tumor mass in the leg 5 hours.

November 9, 1925, 3 Blocks 100 mgs. each, applied over tumor mass in the leg 4 hours.

November 23, 1925, 2 Blocks 100 mgs. each, applied in cervical region 4 hours.

December 7, 1925, 2 Blocks 150 mgs. each, applied to tumor for 3 hours.

January 5, 1926, 1 Block 250 mgs., applied for 5 hours.

January 19, 1926, 1 Block 100 mgs., applied over tumor mass on neck 4 hours.

March 19, 1926, 2 Blocks 100 mgs., applied over tumor mass on neck 5 hours.

June 3, 1926, 1 Block 150 mgs., applied over tumor mass on neck 5 hours.

June 28, 1926, 2 Blocks 50 mgs., applied over tumor mass on neck 5 hours.



FIG. 3.—Showing swelling of right tibia.

The child was discharged November 12, 1925. He did not return to the hospital until September 9, 1926. He was then weak and emaciated and was having great difficulty in breathing and opening his mouth because of the tumor mass in the back of his neck. This mass was so large that it pushed his head forward, and seemed so heavy that the child held his head with his hand most of the time. The eyes showed marked exophthalmos (Fig. 4); the veins on the forehead were distended. The huge mass on the back of the neck was covered with skin showing the scar of a previous operation. The mass was largest posteriorly and to the right extending forward to the lobes of the ears, measuring 33 cms. at this level. It diminished in size below and anteriorly to the ears, ending in rounded masses which were joined to the main mass but felt almost like discrete glands. The tumor was firm, immovable and not tender, but by its very large size seemed to make movement of the head almost impossible. The greatest circumference of the mass was 55 cms. (Figs. 5 and 6.)

There was a firm, movable, painless mass in each axilla, measuring about 3 by 2 cms. The chest and abdomen showed no abnormalities. The inguinal glands were palpable but not enlarged. The extremities were very thin. The fingers and toes showed marked clubbing; the distal phalanges were very wide. The right leg showed no evidences of a recurrence of the tumor.

A urine examination showed many red cells and a few pus cells and *B. coli* was found in a culture of the urine. Blood examination showed a hæmoglobin of 70 per cent., red cells 4,350,000 and white cells 65,200, of which 90 per cent. were large polynuclear

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neutrophiles. The blood chemistry was normal and the Wassermann was negative. Cultures of the blood were sterile and blood aspirated from the tumor showed no organisms on culture or direct smear. The basal metabolism test was +65 per cent. on three examinations.

A large number of X-ray treatments were given to these tumor masses, in addition to the use of radium, but the boy's general condition declined gradually. The veins of the forehead became more distended, the skin showed cyanosis and the eyes and lips were puffed out with œdema; dyspnoea was very marked. The tumor mass continued to grow so that by November the circumference of the neck was 70 cms.

About the middle of November, he began to complain of pain in the calf of the right leg. An examination showed a tense firm swelling of the calf muscles with some local heat and tenderness. An X-ray plate of the fibula revealed irregularities in the periosteum of the upper half of the bone. The white blood-cells were 52,000, of which 94 per cent. were polymorphonuclears, 4 per cent. large mononuclears and 2 per cent. transitionals. It was thought that the mass in the leg was tumor tissue but because of the rapid appearance, the local signs of inflammation, it was necessary to consider the question of a possible osteomyelitis and an exploratory operation was decided upon.

November 24, 1926. Under local anesthesia an incision was made on the side of the right leg exposing the upper half of the fibula. On separating the muscles from the bone posteriorly a mass of tumor tissue was found attached to the posterior surface of the fibula. The tumor tissue was white, firm and friable, resembling sarcomatous tissue. It was removed as thoroughly as possible and the wound closed. Healing occurred per primam.

Sections of the tumor tissue were examined by Dr. W. G. Hibbs, who made the following report:

Densely cellular granulomatous structure diffusely invaded by ramifying cells of periosteal hyperplasia. Diffuse infiltration of adult and fragmented polymorphonuclear leucocytes, neutrophilic, none if any staining with eosin. Endothelial cells, and so-called Dorothy Reed cells, are abundant. No giant cells are present. Opinion.—Periosteal lymphogranulomatosis.

This operation relieved the pain in the boy's leg but his general condition grew steadily worse. Because of difficulty in swallowing and breathing, he took practically no food.

An X-ray examination of the chest showed a tumor-like shadow extending from the mediastinum out into the lung. Cyanosis and dyspnoea became more marked and he died December 9, 1926, almost five years after the first clinical symptom of his disease.

Necropsy Report.—Generalized eosinophilic lymphogranulomatosis (Hodgkin's Disease); huge suppurative eosinophilic lymphogranuloma of the neck (central liquefaction necrosis), and of the right leg; hyperplasia of the axillary, cervical, peribronchial, peri-



FIG. 4.—Hodgkin's disease of bones.

aortic, peritracheal and inguinal lymph-nodes, slight of the lymphoid tissue of the lining of the bowel; marked emaciation; anemia; tumor compression of the cranial bones; marked œdema of the scalp, eye-lids and loose tissues of the abdomen; hyperemia of the adrenals; cloudy swelling of the kidneys; hyperemia of the brain; œdema of the brain; marked fatty changes of the liver, moderate of the lining of the aorta; slight hyperplasia of the spleen; hypostatic hyperemia and œdema of the lungs; slight right hydrothorax; downward-displaced diaphragm and liver; passive hyperemia of the liver; slight hydro-



FIG. 5.—Hodgkin's disease of bones.



FIG. 6.—Hodgkin's disease of bones.

peritoneum; hyperemia of the lining of the duodenum, bowel and urinary bladder; flexion deformity of the right lower extremity; surgical scars (a) of the right leg (ancient exposure of bone), (b) back of the neck; dirt pigmentation of the lungs and peribronchial lymph-nodes; circumcised penis.

This is the body of a white boy whose actual weight is fifty-eight pounds and measures 146 cm. long. The ribs generally are prominent. The circumference of the upper arms is only 12 cm. and of the forearms $11\frac{1}{2}$ cm. on the right side, and the left forearm measures about 11 cm. in circumference. The upper arm is not quite 12 cm. The finger nails are rounded, pale light purple. There is no change of the palms or soles. There are no palpable superficial lymph-nodes below the neck except that a lymph-node of the right inguinal region about 5 mm. in diameter is palpated from the outside. The right lower extremity is flexed as it lies on the table and cannot be straightened out to an angle greater than 75 degrees approximately. There is a scar beginning 4 cm. below the lower margin of the right patella extending inward to the midline and forward to end in a place in the midline of the right leg approximately 4 cm. above the prominence of the right internal condyle and measures altogether 27 cm. long. The scar generally measures 5 to 15 mm. across as though the bone had been opened into at this place. There is a scar on the outside of the right leg, its upper margin being 9 cm. below the lower margin of the right patella extending down for $7\frac{1}{2}$ cm. It is well healed except

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at its middle where the wound is gaping for 15 mm. at a point and 7 mm. side to side. There are six definite places of previous suturing.

The skeleton generally is prominent. The testicles are in the scrotum. There is a mass of lymph-nodes in the right axilla, generally a bunch-like mass 4 by 3 by 2 cm. in general size. The lymph-nodes of the left axilla are well isolated and similarly palpable and not quite so large.

The outstanding feature of the external examination of this child is a huge swelling of the back of the neck which extends around to involve each side of the neck so that the transverse left to right dimension is approximately 21 cm. at the greatest point which is opposite the prominence of the chin. The lips and eye-lids are profoundly swollen, definitely because of fluid for they are soft, pale and fluctuant. The eye-lashes are pointed in because of the swelling. The conjunctivas are pale. There is no evidence of change in the cornea. The measurement of the mass around the back of the neck and across the prominence of the chin is 66 cm., the neck proper measures 46 cm.

The scalp hair extends down behind to cover one-third of the mass approximately, and down to a semi-circular scar a little to the right of the midline which scar altogether measures 24 cm. long and is generally 1 cm. wide. There is a longitudinal scar of the midline of the back of the neck almost at right angles to the previous scar which measures 7 cm. up and down. The tumor of the sides of the neck is profoundly firm and in the most dependent place behind, it is rather baggy and fluctuant. The skin generally of the swelling is a brown to purple tinged, slightly with green, apparently due to stretching of the skin. The scalp behind is easily depressed because of fluid beneath. The cranial bones are a little more prominent to the right of the midline of the skull than is usual. This is due to a slight depression of the left side of the skull behind. The scalp adjacent to the left ear is 12 mm. thick and as soon as it is cut, clear serum exudes in abundance. This is true of the entire scalp. The serum continues to exude abundantly, as previously mentioned, wherever the scalp is cut. The tumor of the back of the neck now has been exposed by an incision from ear to ear over the top of the head and one straight cut back to the lower portion of the neck behind. There is a similar and third circular incision around the back of the neck beginning about 5 cm. below each external ear. After the skin has been reflected at the incisions the tumor is exposed which is generally spherical and begins about 3 cm. below theinion. It is generally a little fluctuant, but firm in places. The lobules adjacent are nodules resembling firmly enlarged and clumped lymph-nodes. The surface is seared in one place and a sterile pipette inserted for culture, but only a little tumor mass is aspirated out. As the mass is cut at the base of the occipital bone after the excision of the fibrous adhesions, the tumor at this place is encapsulated and can be separated cleanly from the bone by blunt finger separation. The occipital bone is raised at right angles to the parietal bone so that from ear to ear behind the usual lambdoid suture line is a firm prominent ridge. The mass on the right side of the neck is similarly encapsulated and after the skin has been stripped away the mass can be separated from the skin by the finger. The swelling of the right side of the face consists of huge lymph-nodes and as the tumor is opened here, large lobulated masses are exposed beneath the cheeks. At the base of the tumor and on the right side about the shoulder, the lymph-nodes are profoundly prominent and measure 2 to 3 cm. long and 1 to 1½ cm. thick. The tumor mass, removed from the back of the neck with much difficulty, weighs in one piece 2269 grams. The tumor is lobulated. These lobules measure 1 to 3 cm. in diameter. In the day light the general color is more yellow than gray. The tumor mass is so intimately adherent to the spinous process of the vertebræ behind that many of them are removed with the tumor. Sections made throughout the length of the tumor by cutting are similar in appearance throughout, except in two places where there is a gray, thick material that exudes easily. In a second place there is a rather thick mucous-like and brown material of central liquefaction necrosis. Smears are taken. There is no noticeable odor. The occipital bone is pushed forward and up almost in a horizontal plane by the huge tumor

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mass. Beneath, small lymph-nodes are found throughout the neck. There is no change of the scalp except cedema. (Fig. 7.)

The calvarium measures 4 to 6 mm. thick generally. The visceral layer of the arachnoid is raised away from the brain by clear fluid. The brain on top is markedly hyperemic. The convolutions generally are rounded. The sulci are 2 to 4 mm. deep. The brain weighs 1160 grams. There is a slight foramen magnum pressure furrow at the base of the cerebellum. Hyperemia is of the entire brain. The lateral ventricle

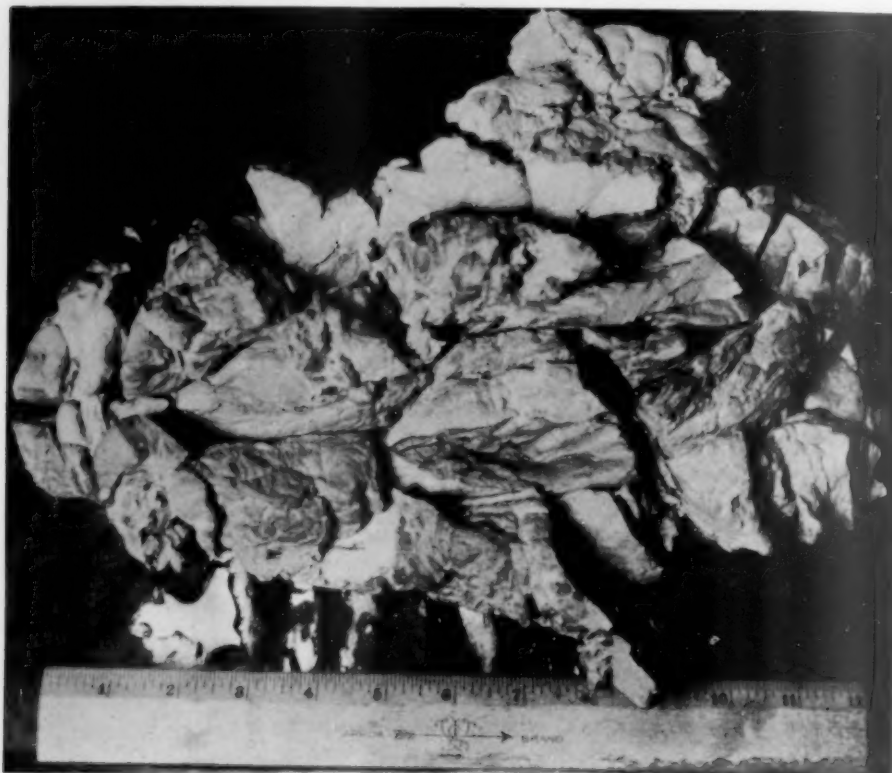


FIG. 7.—Hodgkin's disease of bones.

walls are collapsed. There is no evidence of new growth in the brain which is put at once into preserving fluid for hardening and later sectioning.

After hardening in the usual brain preservative solution, thin transverse serial sections are made by cutting from front to back. The only changes found are those associated with hyperemia and cedema.

The subcutaneous fat of the midline of the trunk in front is generally only 1 to 2 cm. thick. The skeletal muscles are pale pink to brown. There is a little clear brown fluid in the small pelvis, 75 c.c. in all. The loose tissues of the abdomen are generally wet. The gastro-colic omentum has firm nodules in it that measure 10 by 6 by 6 mm. The spleen is normally free, and weighs 80 grams. The surface is smooth and generally pale purple. When sectioned, the Malpighian corpuscles are a little indistinct. In one place there is a mass 3 mm. in diameter, sharply defined and light gray in contrast to the dark brown and purple splenic pulp.

The bowel generally is hyperemic. The diaphragm on the right side has its upper margin opposite the fifth rib, on the left side the fifth interspace. The lower margin of the liver extends down uniformly 6 cm. below the right costal arch. Its front surface is dark brown to red, smooth and slightly fatty in the left lobe in front. There are no

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masses in the liver. The blood-vessels of the mesentery adjacent to the bowel are distinctly engorged. The mesenteric lymph-nodes of the first portion of the small bowel are generally 1 to 2 mm. in diameter, soft and spongy and are oedematous mesentery. The lymph-nodes along the attachment of the large bowel are hyperemic. The small bowel is 565 cm. long. The large bowel is 83 cm. long. There are five areas of ossification of the body of the sternum, three-fourths of which is ossified.

There are few c.c. of fluid in the right pleural cavity and none in the left. The right lung is normally free and generally pink except where mottled with dirt. Near the apex of the right lower lobe the lung is solid in a place $3\frac{1}{2}$ cm. up and down, 4 side to side about $3\frac{1}{2}$ deep. Opposite this area the pleura is profoundly hyperemic and dark brown to pink. When sectioned, front to back through this area, a sharply defined granular-like mass is opened into which consists of multiple small lobules generally 1-2 mm. in diameter, similar in all appearances to the tumor at the back of the neck except that it is darker brown than the tumor of the neck. The mass described of this right lung is presumably an increase in size of the lymph-nodes around the larger bronchi with infiltration into the lung, the parenchyma of which is filled with frothy fluid. Sectioning around the bronchi exposes multiple small lymph-nodes with areas in them like the growth of the back of the neck. In the left lung itself there is not evidence of new growths. The left lung is similarly oedematous and blood stained when cut.

When the right lung is sectioned from back to front the lymph-nodes described are at least six in number and make altogether a mass generally 3 by $2\frac{1}{2}$ by 6 cm. They are smooth and gray when incised. The lymph-nodes of the right axilla weigh 37 grams. The lymph-nodes of the left axilla, with considerable reticulum attached, weigh 13 grams.

The lymph-nodes along the aorta are all prominent, a little more prominent on the left side than on the right. The left adrenal is profoundly hyperemic and weighs 7 grams. The aorta is irregularly stippled with pin-point size yellow plaques. The left kidney weighs $176\frac{1}{2}$ grams. When sectioned front to back, the parenchyma is swollen. The cortical striations are generally distinct. There is no change of the lining of the pelvis of this kidney. The glomeruli are prominent in reflected light. The liver is particularly firm and free from new growth. The right kidney is not weighed by accident, but is approximately identical in size to the left. It is similarly dark red purple-brown and without evidence of new growth. There is one area that is a little soft and gray. These are put at once into a formalin solution. The left adrenal weighs 5 grams, and is like the left in all essentials. The pancreas is firm and, except for a portion adjacent to the duodenum, weighs 114 grams. When cut across in many places the pancreas is definitely firm, normally lobulated and without other evidence of change.

The apex of the heart consists of left ventricle. There is no change of the lining of the inferior vena cava. There is no change of the lining of the heart or coverings of the valves. The lymph-nodes around the trachea are all prominent. These lymph-nodes are like those described previously except that they contain a good deal of soft coal dust. The liver weighs 1370 grams. The back surface of the liver is like the front. The gall-bladder is normally filled with green bile and the lining is unchanged. When sectioned transversely the central veins and lobular markings are distinct particularly because of the prominence of the central veins. Nowhere is there evidence of new growth. The stomach is normally corrugated and in partial post-mortem digestion. The lining of the duodenum is slightly hyperemic.

The urinary bladder is collapsed. Its lining is particularly rigid and a little hyperemic, otherwise unchanged. The inguinal lymph-nodes extend up to the rim of the small pelvis and along its side. There is no change of the right testicle when it is sectioned, or of the left.

The recent surgical wound of the outside of the right leg is opened and extended. The middle half of the right fibula and tibia are cut out for subsequent study. Just

to the right of the prominence of the tibia near the knee, there is a section resembling a lymph-node adherent to the fascia. When the excised tissue is sectioned back to front there is exposed a mass that is similar in appearance to the tumor on the back of the neck, which presumably is encapsulated. There is no change of the thyroid gland. The swelling under the jaw particularly of the left side is of lymph-nodes which have smooth surfaces and are generally gray. There is no evident change of the mandible. There is no change of the base of the tongue, larynx or trachea. The other long bones are not examined.

Histology.—(Paraffin method, H. & E. Stain.) Sections are made of all viscera and are examined especially for changes in the viscera similar to those changes observed in the lymph-nodes. The only changes found anywhere are in the lymph-nodes, or in such structures as are immediately adjacent to lymph-nodes. This includes the spleen, thymus gland, and lymphoid tissue of the lining of the bowel.

Sections of the tumor of the back of the neck are taken in six different places. The structure is diffusely cellular. Cell types are multiple. There are only a few adult lymphocytes. These are replaced by cells that are about twice the size of a lymphocyte. The nucleus is generally pale and in its periphery it contains deeply stained granules that generally extend around the entire periphery of the nucleus with a larger central granule. These are reticulum cells which invade the entire gland mass and obliterate the lymph sinuses. There is a marked proliferation of endothelial cells. The nuclei of these cells occupy three-fourths of the cell. They are generally round and finely granular. Their cytoplasm is clear. Many of these cells have multi-lobed, hyperchromatic nuclei. Plasma cells are abundant.

Throughout these sections there are many endothelial giant cells with "horse-shoe" shape nuclei and a homogeneous cytoplasm. These endothelial giant cells are most abundant adjacent to areas of dense polymorphonuclear neurophilic leucocytes infiltration and necrosis of the surface of the tumor of the back of the neck.

Prominently scattered throughout all sections is a dense infiltration of polymorphonuclear eosinophilic leucocytes. Although these eosinophilic cells are widely distributed, they, like the endothelial giant cells, are most abundant in the areas of suppuration and necrosis, or in the tissues adjacent to these areas. In addition, these eosinophilic polymorphonuclear leucocytes are much more abundantly present in all of the lymph-nodes adjacent to the tumor of the back of the neck, the axillæ and each cervical region, than in the tumor of the back of the neck itself.

The final, uniformly definite feature, is the wide-spread infiltration into all sections of the tumor and lymph-nodes of large, multinucleated cells. The protoplasm of these cells is clear except for scattered irregularly stained shreds. These nuclei generally occupy three-fourths of the total bulk of the cell. Their outline is ragged, and from one to four nuclei are present in a cell. These cells, however, usually have more than one nucleus. These nuclei are rounded, indented and lobed, and lie close together, that is, side by side or in a cluster of three or four to a cell. In each nucleus there is a large nucleolus. The nuclear substance is pale-stained and finely granular. These are the so-called "Dorothy Reed" cells.

Necrotic foci are found only in the tumor of the back of the neck.

(Sections are also made of the adrenals, bowel wall, liver, kidneys, myocardium, spleen, lungs, sciatic nerve and brachial plexus.)

Note.—The following observations have been made: viz., (1) The "Dorothy Reed" cells are much more abundant in the post-mortem tissues studied, than in the surgically-removed tissues of six to twelve months before death. (2) There is a definite decrease in the number of eosinophilic polymorphonuclear leucocytes in the post-mortem tissues studied, than in those removed surgically at these periods.

Bacteriology.—Culture of the heart's blood, the free abdominal fluid, and of the soft pulp of the tumor of the back of the neck, under aerobic conditions, is negative, after seventy-two hours continuous incubation at 37½ degrees centigrade.

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Comment.—Various bones have been involved in Hodgkin's Disease. In the above case, the second cervical vertebra, the tibia, and fibula were affected. Lesions of the sternum have been reported by During⁴ and Lyon⁵; of the skull by Beitzke⁶; of the humerus by Weber⁷; of the femur by Beitzke and Cone⁸; of the clavicle by Burnham⁹; of the ribs by Cone. The vertebræ seem to have been affected more often than other bones. Lesions have been noted by Cone, Burnham, Gibbons,¹⁰ Welch,¹¹ von Muellern and Grossman,¹² Hauch,¹³ Simons,¹⁴ During, Askanazy,¹⁵ Mueller,¹⁶ Weber, Fraenkel and Much.¹⁷ In many cases the periosteum of the posterior part of the bodies of vertebræ have been affected producing pressure on the spinal cord evidenced by symptoms of myelitis. The disease may in this way strongly simulate a tuberculosis of the spine.

The pathological lesion in the bones may be either a granulomatous periostitis, accompanied at times by the formation of osteophytes; or there may be rarefaction of the bone, leading sometimes to pathological fracture. In the bone marrow, yellow or gray nodules may be seen, not sharply demarcated from the red marrow. They consist of fibro-gelatinous material which may go on to cyst formation. Symmers has described three types of changes in the bone marrow.

1. Overgrowth of connective tissue with obliteration of the marrow cavity; (2) histologic changes essentially similar to those in the lymph glands; and (3) extraordinary hyperplastic changes in the marrow cells, especially the myelocytes and non-granular cells of the lymphocyte type.

In relation to the bone involvement, the histopathology shown in the sections taken from the lymph glands and bone marrow in my case is of interest. In addition to the usual bizarre picture of multiple cell types including many Dorothy Reed cells, the sections showed a most marked eosinophilia. While eosinophilia in the tissues is not infrequent at places of low grade infection such as the appendix, Fallopian tubes and the cervix and also at the site of attachment of intestinal worms, it is probably fair to agree with During that although eosinophils are not peculiar to Hodgkin's Disease, there is no other condition in which they are found in such large numbers.

There is, according to Symmers, a general opinion that these eosinophilic cells are derived from the blood. Most of them are polymorphonuclear cells but some are mononuclear. This mononuclear eosinophilic cell is regarded by Symmers as a myelocyte derived from the bone marrow. He believes that the provocative agent of Hodgkin's Disease initiates disturbances in the bone marrow, characterized, among other things, by proliferation of the non-granular mononuclear cells of the lymphocytic type, eosinophils and eosinophilic myelocytes. These cells, together with the myeloplaxes, are thrown into the circulation and filtered out by the lymph-nodes or deposited in them in response to chemotactic attractions, the fibrotic changes in the recipient tissues representing a purely local reactive process. The histologic changes beyond the lymphoid system proper, namely, in the liver, kidneys, etc., represent a reaction on the part of normally existing lymphomatous

foci to the same toxic substance which is responsible for the disturbances in the bone marrow and for the myeloid transformation of the lymph-nodes.

The apparent primary involvement of the bone in my case would seem to support this view of Symmers for lymphatic involvement was not demonstrable until about two and a half years after the onset of the disease. Possibly if more detailed explorations of the bones could be made at necropsy we would find the marrow involved in most instances. At any rate, it would seem advisable in every case of Hodgkin's Disease to make a röntgenological examination of the entire skeleton. This could be supplemented by a biopsy of any suspected areas in the bones. The information thus obtained would add materially to our knowledge of the disease and in certain cases where the bone seems to be involved primarily, it would be a most valuable diagnostic procedure.

In conclusion, from the review of the literature and from the history of the case which I have presented, I wish to point out:

1. That Hodgkin's Disease may exhibit a primary bone involvement simulating a bone tumor or osteomyelitis.
2. That bone involvement, either primary or secondary, is probably more frequent than is generally believed in Hodgkin's Disease.
3. The vertebrae show the most frequent involvement often producing a pressure myelitis simulating Pott's Disease.
4. That marked eosinophilia in the tissue sections in Hodgkin's Disease points to an essential irritation and involvement of the bone marrow in this disease and should lead to a careful examination of the osseous system in such cases.

Grateful acknowledgment is made for the free use of the excellent monograph of J. P. Simonds, *Archives of Pathology and Laboratory Medicine*, vol. i, p. 394, March, 1926, which contains an extensive bibliography.

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PUERPERAL GANGRENE OF THE EXTREMITIES

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PUERPERAL gangrene of the extremities is seldom observed, even in large general hospitals. The rarity of the condition is rather surprising, for it has its origin in infection, and puerperal infection, unfortunately, is still far from uncommon. Stein, in 1916,¹ could collect only sixty-two instances of this complication occurring after delivery at full term, and three following abortion. To this list he added two other cases coming under his personal observation. In one of his patients the gangrene followed a mid-forceps delivery at term; in the other patient it developed subsequent to a curettage performed on the seventh day after a septic abortion at three months. In 1925,² Stein again reviewed the subject, adding cases reported by Rice³ (two observations), Penkert,⁴ Chesky,⁵ Key,⁶ and Knipe.⁷ Besides these, we have found in the literature two other recent cases not included in Stein's lists, which were reported by Hicks⁸ and Entwistle.⁹ Of these eight additional cases, six followed delivery at term and in two instances (Knipe, Key), the gangrene developed after abortion. Thus we have a total of sixty-nine instances of gangrene of the extremities following delivery at or near term, and six subsequent to abortion. Stein included in his reports nine cases of peripheral gangrene following gynecological operations and four developing during pregnancy, but we will not touch upon these in this discussion.

In view of the fact that this condition is so infrequently encountered, we feel that the report of an additional case will be of interest. It might be well to note that in our patient dry gangrene of both legs and thighs, in their entirety, was present. We have not found, in the articles above cited, a description of a similar case with such extensive involvement. In only one of the abstracts in Stein's first paper (Phillip's case), is involvement of the thighs mentioned.

Mrs. H., aged thirty-seven, mother of ten children, was admitted to the Charity Hospital of New Orleans, La., January 26, 1926. She had been delivered normally at home, several miles from the city, January 2, 1926. She remained in bed for ten days. The history obtained did not elicit any evidence of fever during this time; it is possible, of course, that a mild, unrecognized pyrexia may have been present. Soon after she resumed activity, pain developed in both legs, and the legs and feet became numb. She was again confined to bed. The right foot and the lower third of the right leg turned purple, and dry gangrene developed. She was brought to the hospital fourteen days after this condition began to manifest itself.

On admission, the right foot and the right leg up to the knee showed the typical appearance of dry gangrene. The extremity was cold, there was no pulsation in the dorsalis pedis artery, and the skin was dry, brownish, and leathery. The skin of the right thigh and of the left foot, leg, and thigh presented a mottled appearance, some areas being purplish, while others were practically normal to sight and touch. Vaginal examination showed that the uterus was fairly well involuted, the adnexa were appar-

ently normal, and no inflammatory exudate, tenderness, or other abnormality could be detected. The patient's general condition was surprisingly good. The temperature was 100 degrees, the pulse was 120, the respirations 28. The heart and lungs were negative, the abdomen was soft and not distended, and the abdominal organs presented no abnormality. The urine contained some albumen and some red blood-cells. No blood count was made, and no blood culture was taken. It might be noted that the highest temperature was 101 degrees; this was on January 28 and 29.

A few hours after admission, amputation through the middle of the right thigh was performed under ether (M. O. M.). She was in good condition during the operation, and reacted satisfactorily. Two days later (January 28), the left foot, leg and thigh also had become definitely gangrenous, and amputation was performed at the upper third of the left thigh. The gangrene progressed on both sides, and, as a forlorn hope, on the morning of January 30, the left thigh was disarticulated at the hip, and the right thigh was reamputated near the hip-joint. She died on the table just as these operations were being completed, with the symptoms of pulmonary embolism.

Autopsy was performed a half hour after death by Dr. G. H. Hauser. The following notes are taken from the protocol.

Only a partial autopsy was allowed, with examination of the organs *in situ*. Both lungs examined *in situ* were collapsed and devoid of air. Sections into them showed numerous deep purple areas of infarction. The pulmonary artery contained an ante-mortem clot at the bifurcation. In the peritoneal cavity no pathological lesions were found. The uterus was slightly larger than normal and of firm consistency. The adnexa showed nothing of note. Section of the uterus *in situ* showed thickening of the myometrium with fatty degeneration present. The endometrium was thickened and the vessels of both the endometrium and the myometrium showed thrombosis. Section of the uterine vessels near the cervix disclosed thrombosis of the arteries; the veins were empty. The aorta was opened, and in the lower abdominal portion of the vessel there was found a thrombus extending from a point $1\frac{1}{2}$ cm. above the bifurcation down into both iliac vessels and their branches, including the uterine arteries. The iliac veins contained some loose thrombi extending into the inferior vena cava. The arterial thrombus was adherent to the intima, which, after removal of the thrombus, was seen to be roughened and to have lost its normal smooth, glistening appearance. Cultures from this thrombus grew a diplo-streptococcus. Unfortunately, the cultures were discarded by a laboratory attendant before a complete bacteriological study was made. We feel that this organism is apparently similar to the one described by Rosenow in a recent communication³⁰; this streptococcus was isolated by him from five cases of post-operative pulmonary embolism and one case of portal thrombosis. He also found it in all except two of twenty-five other cases, it being isolated from a thrombus, an embolus, or an area of infarction. This organism was found by him to be a Gram-positive diplo-streptococcus, of low general virulence. These characteristics may account for the mild febrile reaction and the lack of constitutional symptoms observed in the cases reported by him, as well as in the patient under consideration. Experimentally, Rosenow found that intravenous injection of pure cultures of this organism in lower animals produced thrombosis and embolism (especially pulmonary), but other lesions were rarely found. Factors such as anaesthesia, operative procedures, slowed circulation, and traumatism of the blood-vessels, which are considered to be of etiologic importance in the development of thrombosis in man, appeared to favor the clot formation in these experimental animals, but in some instances mere injection of the organism sufficed. It was found that nine of these animals developed immunity ten days to two weeks after the injections were completed, and that subsequent injection of the cultures failed to produce thrombosis.

It may be noted that few autopsies are mentioned in the records of the cases collected from the literature. In the patients coming to necropsy, extensive vascular obstruction was noted in most instances, generally involv-

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ing the aorta and its branches (Borié and Du Casel, Bennet, Duncan, Mair), rarely the vena cava and its branches (Knipe), and still more infrequently both sets of vessels (Lancereaux). Vegetations on the heart valves were recorded in five instances.

A classification of the seventy-six cases according to the part affected (considering the chief lesion noted) gives us the following distribution: Lower extremity, one or both (the latter in sixteen cases), after delivery at term, 60; lower extremity, one or both, after abortion, 5; upper extremity, after delivery at term, 10; upper extremity, after abortion, 1. In some instances, multiple lesions were present. Thus, Bigg's case and one of Maurice Reynaud's cases had gangrene of both hands, both feet, the tip of the nose, and portions of the ears. Rowe's first case had gangrene of both legs, five fingers, and the right ear. In McFarlane's patient the right leg and the right arm were involved. In another instance there was symmetrical gangrene of fingers, toes, and ears.

Considering the type of delivery, we find that of the seventy patients at term, nine were delivered instrumentally or had long, tedious labors, in two other instances the placenta was removed manually, and in twenty-nine cases the labor was recorded as normal; in the records of the remaining thirty the details of the delivery were not given. Of the six cases following abortion, the details are lacking in three instances; two of the abortions were septic (one was self-induced with a hatpin), and in the sixth (Key's) the gangrene followed therapeutic abortion at the fifth month. In this case, embolectomy of the common femoral artery two hours after the onset of symptoms was followed the next day by a similar operation on the popliteal artery, but gangrene developed five days later, and amputation of the thigh was necessary. The patient recovered.

The time of appearance of the gangrene is variable; it usually develops one to three weeks after delivery. In Fussel's case it was noted two hours after the completion of the labor, but in this instance the thrombus must have formed during the last few days of the pregnancy. In Bigg's patient six weeks elapsed. In Rouse's second case there was an interval of three and one-half months. It is doubtful in this instance that the gangrene was really of puerperal origin.

Various intercurrent infections are noted in the case reports, *e.g.*, typhoid fever, pneumonia, and pleurisy. General sepsis is recorded as a complication three times, pyemia once, and acute suppurative peritonitis once. Two patients also suffered from puerperal mania. It is interesting to note that in six instances the patients were eclamptics. It is possible that the well-known tendency to rapid coagulation of the blood which is a characteristic of eclamptic patients may cause such patients to be especially susceptible to thrombosis in the presence of the infection which is the main factor. Multiple small thromboses, as is well known, are found at autopsy in most fatal cases of eclampsia.

Etiology.—It appears that infection is always responsible for this formid-

able complication. Note that in the case here reported diplo-streptococci were found in the thrombus. In some instances, as in our patient, it is clear that the infection spread from the uterine sinuses by way of the uterine and iliac arteries to the aorta. In other cases (*e.g.*, the one reported by Entwistle), the thrombosis appeared to be due to an embolus from the infected heart valves of a septic endocarditis. Stein inclines to the view that this group is the larger. In three cases a persistently patent foramen ovale was thought to be concerned in the etiology of the condition. Also, according to Stein,¹ the toxins of the offending bacteria "play an important part, probably through lesions of the vascular endothelium, which in combination with the altered condition of the blood during the puerperium predisposes to the formation of thrombi." This observation is in accord with the findings of Rosenow in his experimental work with the organism isolated by him, but these findings also point rather strongly toward an elective localization on the part of these streptococci.

Diagnosis.—Pain in the affected extremity is a constant finding, and is usually quite severe. Hence its occurrence in a woman manifesting the usual signs and symptoms of puerperal infection should lead us to study carefully the circulation of the limb. Absence of pulsation of the arteries is of course noted below the obstruction in cases of arterial thrombosis. In venous obstruction, the inflamed pelvic veins may be felt by rectal or vaginal examination. The temperature of the limb is lowered, and a livid, frequently mottled, discoloration develops. Arterial obstruction is the more frequent type, is usually sudden in onset, and occurs early in the puerperium. Venous blocking may be sudden or gradual, and tends to appear later than the arterial form. Stein reminds us that phlegmasia alba dolens rarely terminates in gangrene. Early diagnosis is essential if embolectomy is to be attempted, as this operation is of value only if performed within the first twenty-four hours after the development of the obstruction.

Prognosis.—The outlook is extremely grave. Forty of the seventy-six cases of this series died, including three of the six developing after abortion. Only four of the thirty-six patients who recovered were cured without operation (generally amputation). The prognosis is more gloomy because of the fact that the general condition of the patient is as a rule very unsatisfactory. However, Stein, in his second paper, states that the mortality rate has been cut in half by modern methods of treatment.

Treatment.—General supportive measures are indicated. In recent years, embolectomy has been employed in suitable cases. Key collected reports of thirty-six such operations in various types of vascular obstruction which were performed within the first twenty-four hours, with sixteen favorable results, including two cases with the thrombus at the aortic bifurcation. Of Key's ten personal cases, only four developed gangrene after the operation. Early intervention is essential, preferably within the first few hours, certainly within the first twenty-four hours. Buerger (quoted by Stein) states that the operation is successful only when the arterial wall is still undamaged, and

PUERPERAL GANGRENE OF THE EXTREMITIES

secondary thrombosis has not yet occurred. Professor Rudolph Matas, in discussing our case with one of us (E. L. K.) shortly after the patient's admission, predicted the finding of a thrombus at the aortic bifurcation, and called our attention to this work of Key. However, it appeared that a favorable outcome was not to be anticipated after an embolectomy in this instance, and this opinion was substantiated by the autopsy findings. Vignes¹⁰ also suggests that, if arterial obstruction is diagnosed early, before or shortly after the development of gangrene, one may attempt to reestablish the permeability of the artery. If gangrene has already manifested itself, and the line of demarcation has been established, amputation well above this line, according to accepted surgical principles, is indicated. As noted above, most of the cures in this series followed amputation. But as the thrombus is usually located some distance above the line of demarcation in these cases, it follows that the amputation must be high in order to be successful.

Note.—In a case recently cared for by the reporter (E. L. K.) superficial blebs and small areas of discoloration on the skin of the affected leg led to the tentative diagnosis of developing gangrene of the venous type. The patient was suffering from a severe septicemia following a criminal abortion, and died about twenty-four hours after these points were noted. As a definite diagnosis was not established, this case was not included in the series here presented.

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THE PROPHYLAXIS OF GAS GANGRENE IN CIVIL SURGERY

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IT HAS become a very common and wise practice in hospitals, to administer tetanus antitoxin to all severe injuries, promptly on admission. In recent years and especially since the late war, surgeons have been awakening to the importance of reckoning also with gas bacillus infection in these cases. Unfortunately, however, there is no readily procurable serum that can be administered which will afford the same protection as does the antitoxin for tetanus.

In fact, even after the case has been recognized and often times made considerable headway, the perfringens serum, which is used for curative purposes in gas gangrene, is obtained with great difficulty outside of the large cities. Further, while those connected with hospitals admitting a large number of severe accidents daily, are frank to acknowledge the fairly common occurrence of gas gangrene, the reported cases in the literature are comparatively few.

Christopher, in 1922, revealed this paucity of reported cases strikingly. Up to that time, he had only found nine reported cases by seven authors. Baldwin and Gilmour in their later review of 1927 found sixty-four additional cases by twenty-six authors. Yet even this does not begin to tell the story.

The automobile alone, which is so grossly responsible for our worst accidents, is beginning to take its toll by the thousands weekly. Many of these cases that survive are severe injuries, representing the worst types of trauma; such as, crushing wounds, involving muscles, compound fractures and the like. It is a well-known fact that traumatized muscle makes an excellent culture medium for the bacillus Welchii.

While it is true, as Vincent has pointed out, that other organisms, such as the vibron septique of Pasteur and the bacillus œdematous, play a rôle in gas gangrene as do others to a lesser degree, such as the bacillus histolyticus and the bacillus fallax and others, primarily the bacillus perfringens (Veillon) or Welchii, is the potent factor. The others are secondary and undoubtedly from reports tend to make the bacillus Welchii more virulent. Vincent recovered this organism in 82 per cent. of gas gangrene cases during the war. He points out the frequency of this affection during the war and records that among the wounded evacuated to the hospitals of France alone from March 21, 1916, to the end of the war, there were 1851 cases of gaseous gangrene of which 615 were fatal. It is interesting to note that even with this high mortality in an affection that is admittedly grave, he was able by the use of a polyvalent serum prepared from the bacillus perfringens, vibron septique and

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the other allied organisms, to eliminate the disease entirely in all severe injuries that had been given previously only a prophylactic dose of 20 c.c.

Certainly, the problem in civil life is a very similar one. While gunshot injuries are rare by comparison, our modern mechanical and electrical appliances and again the motor vehicle par excellence are producing injuries by the hundreds daily that are fully as extensive and as serious as those produced in battle. This fact cannot be denied and so it behooves every surgeon to be constantly on guard for this most dreaded infection and to promptly use the perfringens serum or preferably a polyvalent serum, if procurable, as soon as the first sign of gas gangrene is recognized.

This, however, is already coping with a serious condition, which progresses rapidly and often causes loss of life or limb. One who has seen one or more cases of gas gangrene surely must have been impressed with the striking rapidity of its progress. The shock, cold clammy skin, rapid feeble pulse are all out of proportion to the temperature and even the visible injury. The picture of death appears very early, once the infection has gotten hold. While the curative serum can be procured with some difficulty, there is, at present, no available prophylactic (especially polyvalent) serum on the market.

Following are two cases, both severe injuries of the pelvis, developing gas gangrene, that recovered after the use of perfringens serum:

CASE I.—P. C. No. 30036, aged nineteen, carpenter, was admitted to the Passaic General Hospital on September 5, 1922, with a severe wound of the left hip.

He was thrown to the pavement from his bicycle by an automobile and sustained a large, deep lacerated wound of the left gluteal region with evulsion of a large mass of muscle. The following day his temperature was 102.6° F., pulse 130, respirations 30. His physical examination was otherwise negative, but he was in a mild state of shock. His white blood count was 9200, the differential was 89 per cent. polymorphonuclears, 10 per cent. small lymphocytes, and 1 per cent. large lymphocytes. A débridement was done and Dakin dressing applied.

September 7, the next day, the wound and surrounding tissues showed evidence of gangrene and the odor was very offensive. Cultures taken at this time showed the bacillus *Welchii* present. Free incisions were made with removal of the gangrenous skin, subcutaneous fat and a portion of the gluteus maximus and iliacus muscles. He was given 100 c.c. of the perfringens serum on September 8. The temperature, pulse, and respiration quickly returned to normal and remained more or less so, except for some post-operative reaction after a suturing October 3, when the wound was entirely free from infection. He healed slowly, but had an uneventful course and was discharged as cured December 12, 1922, about fourteen weeks after admission. He is entirely well at present and attends to his occupation regularly.

CASE II.—W. F., No. 00500, aged twenty-three, hose maker, was admitted to the Beth Israel Hospital, Passaic, N. J., on September 6, 1927, with a small laceration of the right groin, following an automobile accident.

This wound was sutured and a drain inserted. In the course of the day the patient's condition grew worse and his pulse became feeble. The skin was covered with a cold sweat. The wound was opened and a low abdominal incision was made and the peritoneal cavity explored for internal hemorrhage, but nothing abnormal was found and the peritoneal cavity was again closed. There was considerable extraperitoneal venous oozing at the site of the injury, the pubis was found fractured and the muscles torn. He was given a transfusion of 500 c.c. of blood after closing the wound with free drainage.

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The following day, September 7, his condition was grave, the temperature was 103.8° F., pulse 160, hardly palpable, respirations 32. The patient was in extreme shock. A bronzing of the entire upper leg was present with definite crepitation of the subcutaneous tissues, a large amount of thin foul-smelling pus was exuding from the wound. He was again taken to the operating room. Free longitudinal incisions were made in the thigh down through the fascia, which appeared healthy.

X-ray examination showed multiple comminuted fractures of the pelvis. Cultures taken from the wound and inoculated into a rabbit produced gas gangrene in a few hours and the bacillus *Welchii* was recovered from the peritoneal cavity. It likewise appeared in the anaërobic media the following day. Mulford's perfringens serum, 100 c.c. was promptly given and this dose repeated the following morning.

The change in the patient's condition was amazing, even after the first intravenous injection of the serum. The temperature came down promptly, but the pulse was the striking thing. It could be counted with ease and the rate was 120. The patient continued to run some temperature until the eighteenth day, but showed a very steady improvement until the day of his discharge, November 24, 1927, about twelve weeks after admission. He has now practically entirely recovered, is up and about and the röntgenogram shows the pelvis entirely healed, except for some separation in the fracture of the right pubis.

THE TECHNIC OF BLOOD TRANSFUSION *

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BLOOD transfusion is a powerful lifesaving measure of proved efficacy, when used in the presence of definite indications. Improvements in technic and increased knowledge of physiologic chemistry have widened the indications considerably during the past few years.

There is no means of estimating the number of transfusions done in the United States, but in the larger hospitals, it is almost a daily procedure. Geoffrey Keynes¹ says, that in the London hospitals, there were 428 transfusions in 1925, and that, up to November, 1926, over 700 had been done.

The indirect or sodium citrate method is the one most generally practiced at present. There are a great many technics, all of which are more or less satisfactory, but it seems to me that the simple way is the most practicable. I experienced great technical difficulty and waste of time and temper, till I adopted the technic, I shall now describe. (See Fig. 1.)

The technic consists in the use of a Potain aspirator to draw the blood into a graduated bottle, in which there is a vacuum. This bottle should contain 50 c.c. of 2 per cent. sodium citrate solution for each 500 c.c. of blood to be withdrawn. The citrate is first allowed to run into the bottle through the needle and tubing used to collect the blood. The bottle receiving the blood is placed in an irrigator can which contains water at a temperature of 100 degrees Fahrenheit, to maintain the blood at an even temperature. The bottle should be turned back and forth occasionally to diffuse the citrate and prevent coagulation.

When the desired amount of blood is obtained, it is strained through gauze to remove possible clots, and introduced into the recipient's vein by gravity, from a glass cylinder. Normal salt solution proceeds and follows the introduction of the blood. Positive pressure can be put on the column of blood in the cylinder by means of a bulb pump attached to a glass tube passing through a rubber cork which fits the cylinder. This will increase the rate of flow over that by gravity, but it is rarely necessary, and is of doubtful propriety.

One can take 600 c.c. of blood from the donor's vein in five minutes, if the needle is squarely in the vein and there is a strong vacuum in the bottle. Should the stream of blood running into the bottle slacken, it may be that the tourniquet is too tight, the needle may be displaced, or the blood may be becoming more viscous and preparing to clot in the needle. More com-

* Read before the Honolulu County Medical Society, November 4, 1927. "Published with permission of the Surgeon General, who is not responsible for any opinion expressed or conclusion reached herein."

monly, the trouble is a decreasing vacuum due to leaky connections, and increasing the vacuum brings back a free flow of blood. The air can be pumped out of the receiving bottle without interrupting the flow of blood from the vein. (See Fig. 2.)

This technic first suggested itself to me after reading the report of Davis and Cushing² on blood replacement in intracranial operations. This was a method of salvaging the patient's own blood by aspirating it from the field of operation through a glass tube connected by a rubber tube with a collecting



FIG. 1.—Apparatus and instruments used in blood transfusion, indirect, sodium citrate method. 1, Gauze sponges, 4x4 in. 2, Graduate glass, 600 c.c. 3, Sodium citrate, 2 per cent., in 100 c.c. flask. 4, Thermometer, bath. 5, Can, irrigator, white enamel. 6, Bottle, glass, capacity, 1, litre, graduated, with Potain aspirating cork, tubing and metal pump. 7, Medicine glass and dropper. 8, Normal salt solution, in 1000 c.c. flask. 9, Glass cylinder, graduated, 300 c.c. 10, Tourniquet. 11 and 12, Kelly artery clamps. 13, Rubber stopper, fitting glass cylinder, with right angle glass tube passing through, to outer end of which, is attached Paquin cautery bulb, to obtain positive pressure. 14, 15, 16 and 17, Towel clips. 18, Syringe, glass, Luer, 30 c.c. 19, Needles, transfusion, gauge. 12-15, assorted lengths. 20, Tubing, connecting. Tripler U. S. Army General Hospital, Honolulu, Territory of Hawaii.

flask, which is continuously evacuated of part of its air by means of a water pump.

Hahn³ modified this method in some of the details and used a Brophy suction apparatus to create the vacuum in the collecting bottle. McGrath,⁴ in 1914, had previously made use of the aspiration principle in transfusion, and several modifications of its application have been published. So that I hasten to say that this technic is not entirely original with me, for it is essentially the same as used by Keynes, and published by Dr. E. L. Spriggs⁵ of Ruthin Castle, in the *British Medical Journal* of November 27, 1926.

I have modified the Spriggs technic in some details which I think are important, particularly, in changing the amount and strength of citrate solution used per 500 c.c. of blood, from 100 c.c. of 4 per cent. to 50 c.c. of 2 per cent. Again, I use a tube tourniquet instead of the sphygmomanometer cuff, as the tube can be sterilized, and is more easily handled otherwise. I prefer the irrigator can to a jug, to contain the hot water, as an irrigator can with a short rubber tube can be easily drained of its water, and fresh hot water added to get the required heat. I always strain the citrated blood for possible

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clots. Keynes introduces the blood from the same container into which it is received, by using positive pressure and a tube passing to the bottom of the container. It seems to me that a slower rate of flow, *i.e.*, by gravity, is preferable, and less open to other objections.

So far as I have been able to judge, there is but one objection to this method, and it is the result of faulty technic. The criticism is, that clotting of the blood is more apt to occur in its passage through the tubing and Potain aspirator cork, than when the blood is drawn by the simple introduction of a needle or trocar; further, that if clotting does occur, it will be necessary to



FIG. 2.—Withdrawal of blood for transfusion by the indirect sodium citrate method, showing apparatus and draping of patient. The stream of blood passing into the bottle can be regulated at will by increasing or decreasing the vacuum, without interrupting the procedure. Tripler U. S. Army Hospital, Honolulu, Territory of Hawaii.

discard the apparatus, as it is very difficult to remove the clots from the tubing and cork.

In the first place, the aspirator should not be connected to the needle until a free flow of blood from the needle is obtained which shows that the needle has been introduced into the vein correctly. When the aspirator is connected to a needle squarely in the blood stream, a free uninterrupted flow of blood is certain, so long as there is a vacuum in the bottle. Clotting in the apparatus, under these circumstances, is impossible. If, however, the needle becomes misplaced, or is not made to enter the vein completely in the beginning, clotting is very apt to occur in the cork, or anywhere along the course of the flow. To provide for this contingency, it is well to have at hand several needles, and an extra aspirating cork with tubing.

With this technic, I have many times, with but one assistant, transfused a patient within twenty minutes, counting the time taken in withdrawal of blood from the donor. It seems unnecessary to state that the time element is an important one in most conditions calling for transfusion. I have used the same apparatus and transfused salvaged blood from the same patient. The

blood is received into a closed container, and though this may be negligible, there is certainly less opportunity for chance contamination. Another advantage is, that if demanded, the procedure can be carried out by one sterile operator and one non-sterile assistant. But the most desirable feature of this technic from my viewpoint, is the ease with which it can be performed. There is not the strain of holding the needle so as to direct the flow of blood into a container; nor changing position of arm and container as the blood stream slackens or augments; nor the tedious drop by drop addition of citrate, and the constant stirring; nor many other annoying details, unnecessary to mention.

Finally, with this technic, one clean puncture of the donor's vein is sufficient, while with other technics, it is frequently necessary to stick a vein several times. In view of the difficulty sometimes experienced in securing donors, this consideration is of importance. I recommend this technic as a quick, easy, certain, and efficient technic for blood transfusion.

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TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 16, 1928

The President, DR. CHARLES F. MITCHELL, in the Chair

CALVIN M. SMYTH, JR., M.D., RECORDER

REMOVAL OF BRAIN TUMORS

DR. FRANCIS C. GRANT presented two patients from the neuro-surgical clinic of Dr. Charles H. Frazier.

These patients were presented to emphasize the good results which may be obtained following accurate localization and complete extirpation of certain types of these lesions. Encapsulated brain tumors arising from the cerebral envelopes, the meningiomata, present two chief difficulties to the neurosurgeon: first, an exact determination of the position of the neoplasm from clinical and other evidence, which, as will be seen from a consideration of the following case histories, may be extremely meagre; secondly, proper access to the growth and the control of hemorrhage during its removal.

To properly localize the growth requires a detailed history, the closest search for positive neurological symptoms by the varied means at our disposal, X-ray studies, and finally recourse may often be necessary to ventricular estimation or ventriculography. Whether or not a proper exposure of the tumor can be obtained depends to some extent upon its position, although there are few areas on the surface of the brain which cannot be explored. The degree of hemorrhage encountered varies with the vascularity of the growth, its position and the degree of obstruction it has produced in neighboring blood-vessels. Control of hemorrhage depends upon the skill and preparedness of the individual operator and his experience in handling such problems. Multiple operations may be necessary to remove a very vascular meningioma, progressing a little farther at each attempt until complete removal without too severe hemorrhage has been accomplished. Fresh muscle, silver clips, hot wet cotton tampons, bone-wax, a suction apparatus, and patience will go far in carrying through successfully the extirpation of even very vascular tumors. And if a meningioma is completely extirpated along with its dural attachment, the patient can be assured that no recurrence will occur.

CASE I.—*Extirpation of a large right frontal meningioma arising from the falx at the longitudinal sinus and involving the dura over the superior surface of the frontal cortex. Operative recovery.* M. L., a barber, forty-two years of age, white, was referred to the University Hospital on June 23, 1925, by Dr. Clarence Patten. His chief complaint was failing vision. A year previously he first noted failing vision. Ten weeks ago he found he could no longer read. Since that time his vision has continued to decrease

progressively until at present he has barely light perception. There has never been any headache, vomiting, dizziness, or motor or sensory loss noted. He does not believe that his senses of hearing, taste or smell have been in any way disturbed. There have been no dispositional changes. His past medical, family, and social history are unessential. The important points in his neurological examination were slight weakness of left face and hand, a bitemporal hemianopsia with a choking of three diopters in the right eye and two diopters in the left. X-ray studies showed a localized thickening of the frontal bones

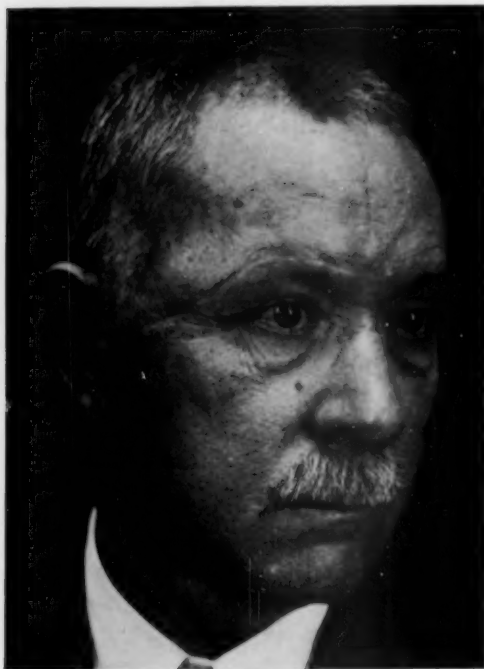


FIG. 1.—Photograph of patient Case I, showing scar.

in the midline, with destruction of the outlines of the sella and the clinoid processes. *Diagnosis.*—Right frontal meningioma arising from the falx low down in front and pressing upon the optic chiasm and sella regions from above.

Operation.—Doctor Grant on July 1, 1925, performed a right transfrontal craniotomy under local anæsthesia. Free bleeding occurred from the midline incision. The bone at about the hairline was thick and vascular, corresponding with the X-ray findings. The hemorrhage was controlled with bone-wax and hot wet tampons. Except for this bleeding the flap was reflected without particular difficulty. A steady continuous ooze was encountered from the dura near the midline. To combat this a section of muscle had been removed from the patient's leg. Placing a flat graft of muscle over the bleeding area and sucking a wet cotton compress down over it, plus light

compression from an assistant's fingers, controlled this bleeding. On reflecting the dura from below upward, the edge of a large encapsulated nodular growth came into view. By cutting the dura close around its lateral margin its outline could readily be determined. The dura in the lower part of the flap was left intact to protect the cortex during the manipulations necessary to remove the tumor. Many large veins running from the cortex to the tumor were doubly clipped and sectioned. Light pressure with cotton tampons over the brain showed that the growth had been freed from its lateral cortical attachments and could be tilted inward toward the midline. By working inside the pial covering of the tumor it was possible to brush from its surface a number of large vessels which were holding it in place. Several fine sutures were now passed through the lateral dural edge of the tumor and by gentle traction on these threads, plus light pressure on the brain, it was possible to tilt the growth upward and inward toward the midline with little or no hemorrhage. A large wet cotton tampon was placed in the tumor bed. The most difficult part of the extirpation was now commenced; namely, the freeing of the growth from its attachment to the falx. By working carefully from either side and clipping and cutting the vessels running from the sinus and finally the

REMOVAL OF BRAIN TUMORS

sinus itself this was finally accomplished. A section of the sinus and a small area of the falx from which the tumor sprang were removed and the growth and its meningeal attachments lifted out. A muscle graft was placed in the tumor bed against the falx, covered with cotton and sucked down solidly against this area. After complete toilet of the outlying wound the cotton and graft was removed. Pressure over the jugulars to raise intracranial tension and reveal bleeding points produced no bleeding and showed that the hæmostasis was complete. But a thin muscle graft was left as a precaution over the sinus area. The dura was closed up to the section removed, the bone flap replaced, and the wound sutured. The patient was entirely conscious and coöperative throughout this procedure. His post-operative condition was good; his recovery uneventful. At present with proper glasses he can read the newspaper and is without symptoms. [Fig. 1.]

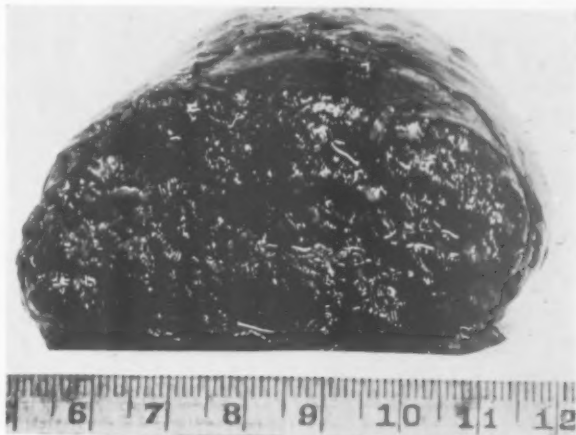


FIG. 2.—Photograph of tumor removed from Case I.

Pathological Report by Dr. Albert Bothe.—The tumor is 6.5 x 6.5 x 5 cm. in size and weighs 175 grams. Grossly it is encapsulated, nodular, firm, and attached to the dura and falx. Microscopically it shows the typical structure and cell type of a meningioma. [Fig. 2.]

CASE II.—*Ventricular estimation followed by right fronto-temporal bone flap, revealing a meningioma arising from the dura in this region. Extirpation of tumor. Recovery.* A. F., a white chauffeur, aged twenty-seven, was referred to the University Hospital on November 27, 1926, by Dr. Samuel Leopold and studied first on the Neurological Service of Dr. William G. Spiller. His chief complaint was failing vision. About eight weeks ago he noticed occipital headaches and failing vision. These headaches came on in the middle of the day, and lasted about two hours. They occurred at intervals of from three to five days with increasing frequency and longer duration until now they are continuous. At the same time his vision began to fail. At present he can read only coarse print. He states that he can see better out of the right side of his eyes. He believes that his memory has been failing for the past year or two. He has had especial difficulty in remembering and grasping the meaning of written matter. There has been a tendency to fall asleep easily. Past medical, family, and social history unessential.

Neurological Examination.—On the first examination the essential features were suboccipital tenderness and headache, suggestively cerebellar gait, ataxia with the left hand in the finger to nose test and coarse tremor in the movements of this hand. No pathological reflexes. A choked disc of four diopters in each eye with concentric contraction of the visual fields was recorded. X-ray studies were negative. An immediate ventriculogram was suggested, but Doctor Spiller thought that he should be kept under further observation. Dehydration by magnesium sulphate was instituted to relieve the pressure upon the optic nerves. After two weeks the following additional

symptoms made their appearance. The headache localized definitely over the right ear, weakness in the left face and hand developed and the memory defect became more pronounced. Impression: Right frontal lobe tumor

Operation.—November 29, 1926, Doctor Grant. As the operator was not entirely convinced that the symptoms could not be due to a cerebellar lesion, it was determined to carry through a ventricular estimation before reflecting a right temporo-frontal flap. Accordingly under local anaesthesia a midline



FIG. 3.—Photograph post-operatively of patient Case II.

incision which could be used later in forming such a flap was made. It was impossible to reach either ventricle. Since an internal hydrocephalus did not exist, the presence of a cerebellar tumor seemed highly improbable. The right fronto-temporal flap was, therefore, reflected without difficulty other than rather severe bleeding from the bone in the midline anteriorly. On raising the flap the dura was tight and tense with two or three points of furious bleeding in the upper anterior area of the incision. These were controlled with muscle grafts taken from the patient's leg. The dura was then opened and the edge of a vascular well-encapsulated tumor lying just in front of the Rolandic vein in the upper antero-median part of the wound was exposed. By careful clipping of vessels running from the cortex to the tumor it was possible to completely free that part of the dura to which the tumor was attached and to sever all vascular connections between the tumor and the cortex. Fortunately the tumor arose from the dura involving the flax so that it was not necessary to ligate the sinus. By making gentle pressure with cotton tampons against the brain about the edge of the tumor, and by brushing off the pia and its vessels from the tumor it was possible to commence its enucleation with very little bleeding. However, since the anaesthetist reported a marked fall in blood pressure he was given an immediate transfusion of 500 c.c. of blood. In the meantime having passed traction sutures through the tumor, gentle tension on them plus light pressure on the brain was continued and the delivery of the mass slowly completed. Several blood-vessels running from the depths of the brain to the tumor required clipping but the growth was finally freed and lifted from its bed without difficulty. A little sharp bleeding accompanied its final removal which was controlled by muscle and cotton placed in the cavity and sucked tight against the bleeding points. Following the transfusion the patient's condition greatly improved. After toilet of the wound, the cotton and muscle were removed from the tumor bed and two small bleeding points picked up in the sucker nozzle and clipped. This completed the haemostasis in the cavity. Pressure over the jugulars by the anaesthetist caused no further bleeding. The tumor bed was filled with salt solution, and the dura reflected from the posterior part of the flap to cover in the area from which the mass had been removed. After inspection and assurance that the wound was dry, the bone

ACUTE SIGMOIDITIS

flap was replaced. Grossly there was no evidence of involvement of the bone by the tumor so that this was considered proper. The galea and skin were sutured as usual in layers. The patient's condition on leaving the table was satisfactory. He received no ether at any time. The post-operative convalescence was uneventful. He is at present, January 20, 1928, in perfect health and working at his trade. [Fig. 3.]

Pathological Report.—Dr. N. Winkeiman, Philadelphia General Hospital. On removal the tumor weighed 150–160 grams. The dimensions were $5.5 \times 5.5 \times 4.5$ cm. It is encapsulated firm, nodular and reddish in color. A section of dura 4×3.5 cm. is firmly attached to the tumor. Microscopically, in cell type, arrangement, and staining reactions, the tumor shows all the characteristics of a meningioma. [Fig. 4.]



FIG. 4.—View of tumor removed from Case II.

CHANCRE COMPLICATING LACERATION OF HAND

DR. HUBLEY R. OWEN presented a patient, a police officer, who had been bitten on the hand by a prisoner. The wound proved unusually intractable and dark field examination demonstrated the *spirochæta pallida*. The blood Wassermann was plus four. The patient received vigorous antilutetic treatment and at present shows only a scar. Doctor Owen remarked that while chancre was undoubtedly an uncommon complication of such injuries, it had occurred in the experience of many surgeons.

ACUTE SIGMOIDITIS

DR. E. L. ELIASON presented a patient, a man, age sixty-one, admitted to the University Hospital, May 5, 1927, with the chief complaint of pain in the lower abdomen. This pain was increased on defecation and urination. The present illness began forty-eight hours before admission with pain in the abdomen, followed by nausea and vomiting. There was pain in the rectum on defecation and pain and tenesmus on urination. Physical examination revealed tenderness in the right lower quadrant of the abdomen. There was no rigidity nor palpable masses. The anterior wall of the rectum was tender by digital examination. The white cell count was 24,000 and the urine was negative. On admission the temperature was 100, the pulse was 96 and the respirations were 20.

A diagnosis of acute appendicitis was made, and the patient was operated upon immediately. The abdomen was filled with cloudy fluid and an acutely inflamed appendix was found lying in the pelvis and was removed through a right gridiron incision. The appendix, though inflamed and covered with lymph, was not the picture of a primary appendicitis of sufficient severity to be responsible for the peritoneal condition. Search was further made for the trouble. Through this opening, a mass could be palpated in the pelvis, and

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an exploratory midline incision was made revealing a sausage-shaped mass, involving about three inches of the sigmoid colon. The walls of the gut were thick, beefy and cedematous and covered with lymph. The mass was evidently inflammatory in character, possibly secondary to a diverticulitis, obstructing the lumen of the gut. The mesosigmoid was cedematous and so thickened as to prevent a satisfactory delivery of the mass. In view of the obstructive nature of the condition, a left inguinal colostomy was done and the lesion left *in situ*. A colostomy was performed through a left gridiron incision.

Six months after operation, a proctoscopic examination was made and a view of the sigmoid colon was obtained through both the anal and colostomy openings. The inflamed area had subsided and the gut appeared to be normal in every respect. Following this examination, the colostomy opening was closed and the abdominal wall was repaired. The patient is now perfectly well.

CHOLEDOCHODUODENOSTOMY

DR. E. L. ELIASON also presented a man, age sixty-four, who had been admitted to the University Hospital, service of Dr. O. H. P. Pepper. The chief complaint on admission was jaundice. For a year prior to admission the patient had noticed malaise, loss of weight and occasionally nausea and vomiting. For two months before admission, the patient had noticed jaundice, clay-colored stools and darkly colored urine. There was intense itching of the skin, but no pain. Physical examination revealed deep jaundice. A hard mass was palpated in the upper right quadrant of the abdomen. The urine contained bilirubin 4 plus. The Van den Bergh direct reaction was immediate and the indirect reaction was 9.0 units. The blood calcium was 10.1 mg. per 100 c.c. The pre-operative diagnosis was common duct obstruction. The gall-bladder was found to be greatly atrophied and fibrosed, being scarcely the size of the little finger. It contained no stones and practically no lumen. The common duct was dilated, containing clear fluid and no stones. The obstruction of the common duct was found to be due to a hard swollen head of the pancreas. The lesion of the pancreas was diagnosed as probably carcinoma. A T-tube was used for the anastomosis and a choledochoduodenostomy was performed. The gall-bladder was too fibrosed and insignificant to be available for anastomosis. The patient is perfectly well at the end of six months.

REPAIR OF COMMON DUCT

DR. E. L. ELIASON presented a third patient, a man, age thirty, who was admitted to the surgical service at the Philadelphia General Hospital, suffering with an external biliary fistula, following a cholecystectomy four months previously. During this period his stools were entirely free from bile. On January 7, 1927, the reporter, through a paramedian incision, dissected out the biliary fistula until the upper end of the divided common duct was exposed, the fistula leading directly into it. After a prolonged search and mobilizing the duodenum, the stump of the lower section of the common duct was found. This had healed over and was closed by a knob of scar tissue. Either at the previous operation a section three-quarters of an inch long had been inadvertently excised or retraction had resulted to that extent, as there was that length gap between the two portions of the duct. The short upper portion of the duct was not sufficiently long to reach either the portion of duct below or the duodenum. The gap was bridged by a piece of rubber tubing about 6 cm. long and of a calibre to fit snugly in the duct lumen. Four catgut sutures were then passed through both ends of the ducts and an attempt made to thus draw the two divided ends together. The sutures had to be tied, however,

SPINA BIFIDA AND CRANIAL MENINGOCELE

leaving fully a half inch gap bridged by the tube. A catgut ligature left long was placed around the exposed portion of the tube and the ends brought up and tied to the abdominal wound edge, thus anchoring the tube to prevent it slipping beyond the defect. The wound was closed with a cigarette drain leading down to the repaired area. In spite of imperfect wound healing there was no escape of bile and the patient has had a complete recovery. The tube is shown by the X-ray to be still in the upper abdomen one year later.

PROSTATIC MIDDLE LOBE HYPERTROPHY

DR. ALEXANDER RANDALL read a paper entitled *The Genesis, Morphology and Surgery of Prostatic Middle Lobe Hypertrophy*.

DR. A. P. C. ASHURST said that Doctor Randall had done notable work in the preparation of the specimens upon a study of which his paper was based. It is very interesting that he has found out a reasonable explanation for the different way in which the prostate may be enucleated: sometimes in one piece, sometimes in three pieces. All surgeons have had such experiences and they often thought their failure to enucleate the prostate in one mass in certain cases, was the fault of their particular way of operating on that individual patient. The speaker was sorry that Doctor Randall had not discovered just what an "enlarged" prostate is: whether it is an hypertrophy, an hyperplasia or a tumor. He saw no reason why it should not be tumor; this would be a very satisfactory solution, for then we would have no reason to look for a special cause until the general question of the cause of tumors can be settled.



FIG. 1.—Tube in common duct six months after operation.

SPINA BIFIDA AND CRANIAL MENINGOCELE

DR. THOMAS A. SHALLOW read a paper with the above title.

DR. FRANCIS C. GRANT said that he had not operated upon a case of meningocele for three or four years; the difficulty with such cases being that

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most of them are brought in the first few months of life with large sacs, frequently with sacs that have ulceration and with large bony defects in the spinal canal as shown in the X-ray; *i.e.*, the spinal cases; the cranial cases have brain protruding into the sac and the speaker regards this as a contra-indication to operative procedure. Regarding the post-operative development of hydrocephalus Doctor Grant believes that the spina bifida acts as a safety valve for the internal hydrocephalus and, in a large majority of cases, removal of the meningocele results in a secondary hydrocephalus. A large series of cases is reported by Cutler of Boston (*Archives of Neurology and Psychiatry*) in which he had 50 cases, 39 of which were operated upon; 16 of these died, the deaths being distributed as follows: 4 hydrocephalus; 4 hydrocephalus plus meningitis; 4 meningitis; 4 to pneumonia and other causes. Of the 39, 8 were alive after the five-year period and in good condition. It would seem therefore that if one has the courage to attempt this type of surgery, and its limitations are understood, a good deal can be done for the patient. From a sociologic point of view, it is a matter of prolonging life of children who will be burdens on society or who may show mental defects. Favorable cases should be given the benefit of the doubt.

DR. THOMAS C. SHALLOW said that of the ten cases operated upon 3 died within three days; 1 died in sixteen days of meningitis, and the other 6 are still living. There has been no return of the spina bifida and there has been improvement in 3 of the cases. The speaker does not regard the correction of bony defects in the spine as any more difficult than those in the head. Post-operative hydrocephalus is an important factor but as its occurrence can not be foreseen, it should not stand in the way. Two of Doctor Shallow's successful cases had ulceration of the sac when first seen.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 25, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

FRACTURE OF THE NECK OF THE FEMUR

DR. SETH M. MILLIKEN presented a woman, fifty-five years of age, who was admitted to the hospital from ambulance, October 28, 1926, late afternoon. While crossing the street one-half hour before admission she had been knocked down by an automobile. She was unable to stand. Examination showed the right leg shorter, adducted and rotated outward. The right trochanter was palpated one and one-half inches higher than the left. Immediate X-ray completed diagnosis of fracture of neck of femur.

The treatment immediately applied by resident surgeon was suspension and skin traction. X-ray, the following morning, showed fragments in fair position with coxa vara due to insufficient abduction.

The assistant surgeon removed the traction and improperly applied a Whitman case. X-ray showed shaft displaced upward necessitating re-reduction.

November 5, tongs were applied in the upper limit of femoral condyles with suspension and abduction, with the Thomas splint and Pierson leg piece. The Pierson leg piece was hung in balance so that the patient could flex and extend the knee by adjusting the overhead weight. This suspension permits motion at the ankle and knee under the control of the patient and maintains the tone of all muscles of the extremity. Spontaneous contraction of the quadriceps is necessarily limited during the application of the tongs but shortly after the removal of the tongs voluntary control of the quadriceps is regained. The inward rotation of the femur is maintained by the flexion at the knee. Twenty-five pound weight attached to tongs for thirty-six hours gave over-correction of shortening. Weight then reduced to eighteen pounds maintained fragments in correct apposition.

X-ray, November 10, showed fracture surfaces in contact with too great abduction. This was corrected.

November 16, traction weight reduced to thirteen pounds.

X-ray November 29, showed fragments in contact.

Tongs were removed on the twenty-seventh day, and skin traction applied without changing position of extremity.

December 10, patient showed voluntary power of quadriceps muscle.

December 29, callus was shown in X-ray.

December 31, voluntary motion at the hip-joint was present in what seemed to be normal arc.

January 13, suspension was discontinued. At this time extension at knee-joint was limited at about 165 degrees due to the long continued suspension with flexed knee.

February 11, (about thirteen weeks) patient was allowed to walk with crutches.

Four months after application of tongs there was full extension in hip and knee and full control of thigh muscles. Patient discharged improved March 10, 1927, nineteen weeks after admission, able to bear some weight

on injured side, 80 per cent. of normal motion in hip, and extremities equal by measurement.

Used crutches part of the time for following three months, since then has been walking with a cane.

X-ray taken last week shows complete bony union between the neck and the shaft with straightening of the angle between these two. The lesser trochanter is still displaced but the plane of fracture is undiscoverable at this time.

The case is shown because of the good reduction accomplished by this method and because of the comfort of the patient during the treatment.

Traction suspension seems the most satisfactory method of obtaining reduction of fractures in the thigh and arm bones. The disability of the patient is lessened because if the traction is applied in such a manner that the function of the muscle is maintained throughout the treatment, that is, if voluntary motion of the adjacent joints can be permitted without displacing the fragments, the muscle tone is maintained and union is hastened by the maintained nourishment of the part, which does not show the atrophy inevitable under treatment by immobilization.

DR. JOHN J. MOORHEAD said that Doctor Milliken's patient illustrated the advantage of strap traction over plaster-of-Paris. The patient he presented had no observable limp or eversion of her foot in walking across the room. Personally, the speaker had no experience in treating fracture of the femur by any form of skeletal traction. During the past year in nearly all of his cases he had used strap traction instead of plaster-of-Paris and found it very useful, especially in debilitated and aged persons who so frequently suffer from fracture of the neck of the femur. Doctor Moorhead showed röntgenograms of two patients. The first series was of a woman ninety-two years of age who had slipped and fallen, and sustained an intracapsular fracture of the femur in March, 1926. Pictures taken on that date and in October, 1926, and April 11, 1927, showed progressive repair. The patient is able to walk with the aid of a cane and one person. She is the oldest patient he has had. The other series of X-rays were those of a woman eighty-eight years of age whose fracture of the neck of the femur was also the outcome of a slight trip and fall. She had a stiff knee and the shaft was driven through the neck and through both trochanters. Traction of fifteen pounds was applied. The pictures were taken on December 10, 1927, at the time of the accident, on December 19, and on January 19th, and the last two show evidence of bony repair.

Doctor Moorhead wished to emphasize everything Doctor Milliken said of the advantages of strap traction over immobilization and plaster-of-Paris in this type of patient.

DR. CLAY RAY MURRAY said that one difficulty with strap traction in the treatment of fracture of the neck of the femur was that the skin will not stand any large amount of weight and this form of treatment requires a good deal of weight to get results in the overcoming of shortening and the maintenance of relatively fixed abduction. To overcome this deficiency he had tried out the idea of applying a double set of traction straps, one set

FRACTURE OF CAPITELLUM OF HUMERUS

attached to the leg and one to the thigh, as the leg lies in wide abduction in a Thomas splint. To each set of straps twenty-five or thirty pounds can be attached without too much skin irritation from the pull, giving sixty pounds traction to correct the shortening, and better fixation for the abduction. This also solves the difficulty that one meets in skin traction in that if one of a set of straps comes off the other set is still working, and maintains at least twenty-five or thirty pounds of traction until such time as the loosened strap is renewed, instead of the patient being without strap traction at all in the interim as is the case when one of a single set of straps gives way.

INTRACAPSULAR FRACTURE OF THE CAPITELLUM OF THE HUMERUS

DR. FENWICK BEEKMAN presented a woman, age thirty-seven, who on August 14, 1927, tripped and fell, landing on her extended right arm. She immediately complained of pain about her right elbow and found she was unable to flex or extend her forearm, it being held in a position of about 135 degrees.

She was seen one hour later at which time she complained of pain about her right elbow and down the volar surface of her forearm. There was no localized point of tenderness, though any attempt to move her arm accentuated the pain. The arm was placed in a sling and on the following day, an X-ray which was taken, showed a fracture about the external condyle of the humerus with, however, no marked amount of displacement. The patient refused an anæsthetic and therefore the arm was placed at a right angle, in an anterior-posterior moulded splint. At no time was there any swelling or ecchymosis seen. Motion was started in about three weeks and continued until October 20, about a period of two months after the injury, but the range of motion was not increased, it being limited to within an arc between 135 and ninety degrees. There was no interference in supination or pronation of the forearm and there was no pain as long as the motion at the elbow was not forced. At this time it was also noted that there was a slight loss of carrying angle. An X-ray taken showed an intracapsular fracture of the capitellum of the humerus, the fragment having been forced up and anterior to the remaining portion of the external condyle of the humerus by the head of the radius, which impinged upon it, when the arm was flexed to a right angle. There was no sign of callus. (Fig. 1.)

November 14, the patient was admitted to the Ruptured and Crippled



FIG. 1.—Intracapsular fracture of the capitellum of the humerus, showing the displacement of the fragment and the lack of callus formation.

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Hospital and the fragment of the capitellum was removed. An incision was made on the anterior surface of the elbow-joint in the groove between the supinator longus and the brachialis anticus muscles. The muscular-spiral nerve was found and retracted outward. The anterior capsule of the elbow-joint was found bulging forward. A crucial incision was made in the capsule and the fragment was easily removed as it was held by only a few adhesions of fibrous tissue. The rent in the capsule was repaired with chromic catgut and the overlying tissues were closed over it without drainage. The arm was placed in a position of about seventy degrees.

Active motion was started two days later and physio-therapy ten days after operation. The patient now lacks only about ten degrees flexion and about twenty degrees extension. There is a loss of carrying angle. X-ray shows a normal end of the bone with the exception of the capitellum which is missing from the humerus. There is no deposit of callus.

This case is presented because of the rare type of fracture. Its full extent was not recognized at first and the question now arises whether it would have been possible to have reduced the fragment and held it in its position when it was first seen? If it had been reduced would union have taken place? Doctor Beekman thought that it would have been impossible to have kept the fragment in position if it had been reduced, and that union would have not resulted, as the fragment was apparently free within the joint.

PLASTIC FOR ULCER OF THE LEG

DR. FENWICK BEEKMAN presented a woman of forty-five years of age, who was admitted to Lincoln Hospital, February 12, 1926, with an infected ulcer about the left ankle. This had been present for three months. It healed rapidly when she was put to bed but as soon as she was up and about it broke down. On two occasions, while in the hospital, it healed followed by its reappearance, as soon as she was allowed up. The ulcer was situated just below and posteriorly to the external malleolus. Its edges were irregular and its base was clean. It was oval in shape measuring about one and a half inches in length by one inch in width. It was attached to the under-lying deep fascia of the ankle.

In the middle of July, 1926, the patient was placed in bed and the ulceration healed. On the 2nd of August a wedge shaped piece of skin, with its base down and including the scar of the ulcer, was excised. A pedicle flap from the dorsum of the foot was raised and rotated on its pedicle posteriorly into the position from which the ulcer had been removed. A full thickness Wolfe skin graft was removed from the thigh and sutured in to the position from which the pedicle flap had been removed.

On the seventh day the dressings were removed and it was found that the pedicle flap had healed in its new position and that the full thickness graft had completely taken. In about a month's time the patient was allowed out of bed and since then there has been no re-occurrence of the ulcer.

This patient is shown to demonstrate the possibility of using pedicle flaps and full thickness skin grafts in certain types of ulcers of the leg. Apparently the ulcer, in this case, was due to a lack of local blood supply. By using a pedicle flap to cover the defect, from which the ulcer had been excised, a new blood supply to the part was established by means of the vessels in the subcutaneous tissue of the flap, these vessels being guided from a healthy portion of the limb by the flap.

CARCINOMA OF THE RECTUM. LATE RESULTS

CASE I.—DR. ALLEN O. WHIPPLE presented a woman, age forty-seven, who came to the Presbyterian Hospital, out-patient department, June 8, 1922,

CARCINOMA OF THE RECTUM. LATE RESULTS

complaining of dyspnoea on exertion, palpitation and precordial pain. She gave a typical history of attacks of acute rheumatic fever, very severe one year ago. In the course of eliciting her system diseases, she said she had for the past year been severely constipated and had noted bleeding from the rectum fairly frequently, at times in fairly large amount. She complained of no rectal pain or tenseness.

Physical examination revealed a marked pallor, an enlarged heart, rate 100, with signs of mitral stenosis and regurgitation. *Rectal examination* showed a typical narrowing of the lumen with a hard nodular movable mass on the left and posterior aspect of the rectal wall 12 cm. from anal margin. A small section removed by proctoscope showed carcinoma. Hæmoglobin 45 per cent. Red blood-cells 3,000,000. Wassermann reaction negative.

The patient was transfused and two days later under gas and ether anaesthesia a radical abdomino-perineal removal of the pelvic colon, rectum and anus by the Myles technic was done in one stage, using a left lateral colostomy. She made a satisfactory recovery, her heart behaving very well during and after the operation. She went home on her twenty-eighth day with wounds healed. It is now sixty-nine months since her operation. Her only complaints are related to her cardiac lesion. Colostomy functions satisfactorily and when last seen in November she showed no signs of local recurrence or abdominal metastases.

CASE II.—Male, age forty, was admitted to the Presbyterian Hospital, out-patient department, May 25, 1922, complaining of bleeding by rectum, repeated painful ineffectual defecations, loss of eighteen pounds in one month. Past history and his present system history was essentially negative. He had had no treatment for his present trouble. He was a rather pale, apprehensive man, complaining bitterly of his constant desire to empty his rectum. General physical was negative. No cardiac or pulmonary lesion. Liver not enlarged. Rectal and proctoscopic examination revealed an annular growth 8 cm. above the anus, not attached to sacral wall. It was questionable as to its attachment to the bladder wall. Section showed adeno carcinoma. Urinalysis and Wassermann negative. Phthalein 48 per cent. Blood Urea 0.35 gm. per litre.

June 12, 1922, a one-stage combined abdomino-perineal removal of pelvic colon, rectum and anus with left lateral colostomy by the Myles technic was done. The patient stood the procedure well and made good progress for five days. But on the evening developed a cough and hiccough and on the sixth day he complained of sudden pain in the upper angle of his abdominal wound and on examining the dressing it was found that a loop of ileum had protruded through the upper angle of the wound. This was repaired immediately under local anaesthesia and the subsequent course was uncomplicated save for threatened decubitus requiring an air bed. His perineal wound filled in slowly so that he did not leave the ward until the fifty-second day after operation.

He has been examined ten times in the Surgical Follow-up. The last time in October he gave no evidence of local recurrence or abdominal metastases. He has maintained his normal weight and is working regularly. It is now sixty-eight months since his operation.

CASE III.—Male, age fifty-six, admitted December 28, 1922. Six months prior to admission had attack of mild diarrhoea for one month—no blood. All right till five weeks ago—return of diarrhoea with ineffectual evacuation. Fresh blood in stools. No pain. Loss of five pounds in five weeks. Marked weakness and exhaustion, underdeveloped and undernourished. Marked myo-

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pia. Bad teeth. Lungs and heart negative. Right inguinal hernia reduced. Blood pressure 128/80. *Rectal*.—Irregular firm cauliflower mass on posterior wall, not involving anterior wall. Freely movable. About 8 cm. long. No ulcerations felt. *Laboratory*.—Red blood-cells, 4,900,000. Hæmoglobin 83 per cent. White blood-cells 10,000. Polymorphonuclears 84 per cent. *Diagnosis*.—Cancer of rectum. Confirmed by pathological report date of operation, December 30, 1922. Combined abdomino-perineal resection of rectum in one stage. Pathological report shows metastases in several lymph glands and tumor invading muscularis. The feeling was that it was not all removed.

Course.—Very restless and mentally unstable for about ten days post-operative. This at first attributed to poor urinary excretion for the first four days and paralytic ileus for four days. Daily blood ureas averaged 0.8 gms./L and uræmia was questionable. On fourth day had good bowel evacuation through colostomy. Iodoform poisoning suggested and urine found iodine + + + +. Packing removed and symptoms gradually cleared up. Patient steadily improved. Wounds all healed cleanly. Abdominal wound healed. Rectal wound five and one-half inches lined with clean granulations on discharge.

Patient seen ten times in Surgical Follow-up with 444 result. Admitted again five years after operation with strangulated right inguinal hernia. Hernia repaired and patient discharged after good recovery in good condition, December 21, 1927.

ULCERATIVE COLITIS

DR. HAROLD E. SANTEE read a paper with the above title for which see page 704. To illustrate his paper Doctor Santee presented two patients, as follows:

CASE I.—Man, age forty-six, admitted to Bellevue Hospital, December 5, 1926. His previous history is apparently relevant in its surgical aspects only. He had been operated upon for the following conditions: Hemorrhoids in 1908, appendicitis in 1913, cholecystitis in 1916. Three years prior to admission he suffered for six weeks from an illness similar to the present followed by a long remission with constipation. About six weeks ago he began to have diarrhœa with rectal tenesmus and his stools gradually increased in number to twelve or fifteen a day. Colicky pains were present at times. The stools have been black at times, sometimes "pussy" and mucoid, sometimes showing obvious blood. Mild fever has been present at times. During the past week, however, all symptoms have been increasing until two days ago pain in the abdomen, prostration, dehydration and fever in addition to the bloody diarrhœa and tenesmus caused him to call a physician. Vomiting occurred two days ago. Diarrhœa and tenesmus have been the two most distressing symptoms.

Examination after admission to the Hospital showed a well nourished man in obvious pain with evidence of some dehydration in mouth and tongue. The temperature was spiking to 102.4. The urine and blood chemistry were normal. The blood picture showed: Hæmoglobin 100 per cent., white blood-cells 13,600, polymorphonuclears 77 per cent. Physical examination showed a rounded somewhat distended abdomen with definite tenderness and rigidity in the left lower quadrant. At times a sense of mass would be made out here. Rectal examination was very painful and showed exquisite diffuse tenderness within the sphincters and a small recent fissure anteriorly in the anus. Rectal irrigations were started and proctoscopic examination

ULCERATIVE COLITIS

attempted but were too painful to the patient. Increasing left lower quadrant tenderness and rigidity caused considerable apprehension to the surgeon and on December 9, 1926, exploratory operation was done through a lower left rectus incision. The entire rectum, sigmoid and descending colon were greatly thickened, cedematous and congested, the changes being most marked in the sigmoid which showed numerous fibrinous plaques and many recent fine adhesions both to adjacent coils of small intestine and to the parietal peritoneum. Sacculations of the gut were obliterated by the exudative process, mesocolon was cedematous, even gentle handling produced small areas of stippled hemorrhage. The colon proximal to the splenic flexure appeared normal except as adherent to the site of old gall-bladder and appendix scars. Cultures were taken from the wall of the colon (reported sterile) and the wound was closed. Dilatation of the sphincter ani was then done and the patient returned to the ward. A broth diet with small repeated doses of deodorized tincture of opium, daily emetine injections, and rectal irrigations failed to show improvement in fever, diarrhoea and tenesmus. Five days after exploration, cæcostomy was done through the old McBurney scar. The opening was made into the cæcum on the following day. Hot saline and hot tap water irrigations were instituted twice a day. The broth diet with opiates was continued. The temperature became normal on the eighth day following cæcostomy only to rise slightly again and range between 99 and 100, until the fortieth day. Milk and soft foods of low residue were gradually added to the diet. On the seventeenth day after cæcostomy a transfusion of 500 c.c. of blood was given. Irrigations were changed to potassium permanganate solution (1-8000) after the first two weeks due to the bacteriological reports and these were kept up until the fiftieth day when he was having one formed stool a day. After the cæcostomy and with the irrigations the stools decreased in number from fifteen to twenty a day to six or eight and the blood disappeared at the end of the first week. These stools were very purulent and looked like a pyocyaneus pus which they later proved to be.

The bacteriological reports on the stools as made by Doctor Torrey were as follows:

December 16, 1926. Serous fluid with clots of blood and fibrin. *B. coli* and *B. pyocyaneus* extremely numerous. The *B. coli* were not virulent. No streptococci recovered.

December 21, 1926. Purulent fluid, no fecal matter. Gram stained film shows many pus cells. No chain streptococci. Gram-positive diplococci (enterococci) and single cocci numerous. Cultures show *B. coli* and *B. pyocyaneus* as in first specimen. Also some coccus colonies—staphylococcus (pale aureus). In an anaërobic fluid culture many streptococci were seen in the stained film, some of these in diplococcus and some in long chain forms. These would not grow on aerobic plates and have not been isolated. They are apparently anaërobic types and are more likely than anything else found to be a primary factor in the colitis. It is also unusual to find such large numbers of *B. pyocyaneus* in the colon and it is possible that they may have a secondary rôle in the inflammatory process.

January 3, 1927. The *B. pyocyaneus* which were so prominent in the first two specimens have disappeared. Some long chained streptococci developed in the cultures of the same morphology as seen in the previous specimens. It is likely that the primary factor in the case was the streptococci with the *B. pyocyaneus* secondary. The specimen at this time consists of light brown fecal lumps, with no blood and some mucus and it is of interest that

the *B. pyocyaneus* has disappeared coincidentally with the improvement in the character of the stool.

Improvement in the patient was progressive and after the fiftieth day he was up and about with one stool a day. One irrigation a day was given. After five weeks of afebrile symptom-free convalescence the cæcostomy was closed on the eighty-seventh day after operation. In another three weeks he was discharged from the hospital and has remained well since.

CASE II.—This patient, a woman, age forty-five, on admission to Bellevue in 1923, was shown to illustrate the late effects of a subacute or chronic colitis. At exploration in June, 1923, her sigmoid and descending colon together with the mesocolon were thickened throughout, rather firm in consistency, but showing small stippled hemorrhagic areas wherever handled. On a dietetic régime, she continued for fifteen months with increasing constipation. At this time a short tubular stricture of the rectum was made out but not markedly constricting. At operation with a view to cæcostomy in September, 1924, the same changes in the cæcum and ascending colon were noted as in the sigmoid on the previous operation. Cæcostomy was done and irrigations given for six weeks. She was allowed to go home and the cæcostomy closed spontaneously after approximately eight months. A small caecal hernia repair was done the following year.

She remains well but constipated and shows on examination at this time a hypertrophy or thickening of the colonic wall that is very obvious on palpation. Her stricture of the rectum seems to be of the same calibre as on previous admission and admits the index finger fairly readily. The mucosa is apparently normal in appearance and feel and the stricture is probably due to old inflammation within the wall of the colon with restitution of the mucosa to practically normal.

DR. WALTON MARTIN remarked that at the outset in any discussion on colitis it is well to keep clearly in mind that the term ulcerative colitis or dysentery is used to designate a number of specifically distinct diseases; that we have protozoa colitis, bacillary colitis and ulcerative colitis from the ingestion of certain toxic substances. In the protozoa and bacillary forms the microparasites seem to set up lesions beneath the mucosa and as the lesions progress there is destruction of the glandular coat by necrosis or by an infiltration of round cells, so that numerous ulcers are left. It is difficult to think that any solution flushing the surface will do more than carry away fibrin, necrotic fragments and surface bacteria and thus prevent secondary infection and decomposition of the colon contents. The amœbæ or bacteria beneath the ulcerating surface are not reached by the antiseptic solution.

The function of the colon is, as all know, to take up fluids and convert the semi-fluid contents of the small intestine into solid feces.

In colitis this function is interfered with. Not only is the fluid not absorbed but a variety of putrefactive changes in the unabsorbed intestinal contents occur with the formation apparently of acrid substances which irritate the mucosa. Regular flushing has an important therapeutic action in washing out these irritants, but can it not be accomplished effectively by colonic irrigation given through the anus? Diverting the contents of the small intestine, added to flushing, must accomplish the same purpose in a

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better way. Both measures, however, simply attempt to create conditions more favorable for the body cells. They do not affect, except indirectly, the underlying infection. These conditions hold for all ulcerative colitis irrespective of etiology.

A review of the several operations which have been devised to either irrigate the colon or prevent the contents of the small intestine from passing through the colon may be pertinent to the discussion.

Seventeen years ago, Doctor Gibson of this Society read a paper on the Surgical Treatment of Colitis before the International Society of Surgery at Brussels and referred to an earlier paper on a valvular cæcostomy for chronic colitis, written in 1902. The method he used was a cæcostomy done much as the Kader operation is done in the stomach. About the same time, Weir, stimulated by Doctor Gibson, introduced appendicostomy. Since then, every now and again, cases are shown demonstrating marked improvement after irrigation through either the cæcum or appendix.

Doctor Elliot showed a patient before this Society, about eighteen years ago, suffering from amœbic dysentery treated by performing appendicostomy and irrigating the colon with quinine. It was evident in the discussion at that time that a permanent opening was the aim and that recurrences were expected. Now-a-days Stovarsol (introduced by Marchoux of the Pasteur Institute in 1925), a synthetic chemical compound which seems to be a powerful amebicide, would probably have cured this patient.

Doctor Santee has properly reached the conclusion that cæcostomy is a more satisfactory operation than appendicostomy and advocates a liberal opening, (one to one and a half inches), so that not only can the bowel be irrigated but the fecal contents of the colon pass out through the opening to some extent, a condition carefully avoided in the earlier technic. Doctor Martin expressed the belief, however, excluding the large bowel altogether by an ileostomy is a better operation, notwithstanding the theoretical disadvantage of the difficulty of closure of the ileostomy. A case was reported a few years ago by Dr. Harvey Stone in which the patient gained sixty pounds and was well and free from all symptoms two years after the closure of the ileostomy.

It seemed to the speaker inadvisable to do any operation until the chronic ulcerative colitis has resisted medical treatment for a number of months and until symptoms of a severe exacerbation have made their appearance.

In closing, Doctor Martin referred to the statement that the first clinical description was Sir William White's in 1888. Aside from others, the late Francis Delafield of this City was especially interested in all forms of colitis. His autopsy reports and case histories date back to the Seventies. He has given accurate descriptions of the morbid anatomy of the various forms of colitis with case histories.

Besides the protozoa and Shiga-Kruse and Flexner bacillary dysenteries, there are apparently a number of other forms usually grouped under the general term idiopathic colitis. Doctor Santee has referred to the work of

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Jacob Bergen at the Mayo Clinic who has described a Gram-positive diplococcus as a specific infecting agent in patients with this form of colitis, who have come under his observation, but those competent to decide seem most doubtful of the value of his work. He has cured or greatly relieved his patients by the removal of small local foci in tonsils, roots of teeth, etc., in which he has found the same diplococcus, added to treatment by vaccines and topical applications.

DR. EDWIN BEER said that in making the correct etiological diagnosis, he had had great difficulty in distinguishing between the specific amœbic and the non-amœbic cases. Emetin administered hypodermically did not assist in the differentiation whereas proctoscopy and the study of the stools had at times helped. In the typical non-amœbic cases at proctoscopy he had noticed punctate ulcers, whereas in the amœbic cases, he had found large irregular undermined ulcers. All cases do not require surgery and many are treated—even quite serious cases—satisfactorily medically.

In one case of severe hemorrhagic ulcerative colitis, in which the patient had had two attacks and had to be transfused, the condition was controlled by medication and colonic irrigations. Subsequently, the patient developed acute gangrenous appendicitis for which he was operated on, and during convalescence the colitis again became troublesome, and without doing anything surgically to the colon, under medical treatment the colitis was controlled once again and the patient has been in good health for almost two years. It was impossible to prove in this case what the etiological factor was.

If one decides that the case does not respond to medical treatment, the question comes up, should one regularly do a wide artificial-anus operation in the ileum or cæcum. Having had excellent results with the valvular cæcostomy—the appendix having been removed at the same sitting—he would prefer to do this operation as a first-step, and if it failed, he would favor a complete ileostomy.

The oldest case of ulcerative colitis that he has had under observation continuously was a young woman who had a cæcostomy of this type done eleven years ago for a very severe ulcerative colitis with high temperature. The patient was desperately ill and had not responded to medical treatment, and at operation the cæcum and colon were studded with white plaques of localized suppuration. Her proctoscopy had shown multiple pinhead superficial erosions; no amœbæ and no bacteria with gram-stain. A large rectal tube was sewed into the valvular cæcostomy allowing almost all the stool to be diverted. After four days irrigations of the bowel were begun, and later on emulsions of bismuth were run into the colon through this tube. The patient made a satisfactory convalescence and the tube was left in with the object of controlling any relapse, the size of the tube being reduced to that of a small catheter—about 12 to 14 fr. The patient relapsed in a few months, and irrigations, first with silver nitrate and subsequently with ichthyol 2 per cent., were instituted. The latter irrigations apparently controlled the condition rapidly as the stools became normal, mucus and blood disappearing.

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The cæcostomy wound never leaked and there was no soiling and no discomfort. For two years the patient was in excellent health even passing through a severe attack of influenza, and she gained thirty pounds. There was on several occasions a little blood just preceding defecation, apparently from local irritation; there was no diarrhoea and the stools were regular and formed. In 1921, seven years after operation, the patient continued in the same excellent condition having required only three irrigations of her colon during the past twelve months; she was able to attend to all her activities normally. In 1922, she had an occasional attack of cramps in the abdomen and occasionally several movements. She went to Cuba in this year where, following exposure or indiscretion in diet, her diarrhoea came back, and while out of town she attempted to control the condition by flushing the bowel with bicarbonate of soda. On returning to New York her condition again was serious and temperature elevated. Under careful irrigations, the condition was controlled. Repeated examinations of the stool had been made and on one occasion *amebæ histolitica* were demonstrated in 1922 by one Laboratory. Following the relapse of 1922, the patient has remained perfectly well so that in December, 1927, the tube, which had been in ten and one-half years, was removed and the patient continues in excellent health.

The experience with this case and others of similar character, indicate that it is risky to close the colon as these patients are very liable to have remissions which are easily controlled if one has access to the bowel by means of a valvular cæcostomy which can be maintained without annoying the patient for many years. If, on the other hand, these procedures fail to control the situation, the more radical procedure of ileostomy with complete severance of the small intestine, should be performed and one can continue medicating the colon through the original valvular cæcostomy. It is important in irrigating to use bland solutions so that one can really effectively wash off the surface of the colon; an irritating solution which produces peristaltic contractions prevents this complete lavage.

It would be most gratifying if the serum which has been elaborated at Mayo's would prove effective in these trying cases as despite all our efforts, the patients are liable to be sick a very long time and many of them become chronic invalids if they do not die of the ulcerative colitis.

DOCTOR SANTEE, in closing the discussion, said he believed it is extremely difficult to form proper conclusions in these cases marked by such diverse clinical courses but he considered cæcostomy such an easy operation that even were it necessary after closure of one cæcostomy, it could be reopened in case of another exacerbation. This would give an interval of freedom from the discomfort of a cæcal fistula even if another exacerbation indicated a second cæcostomy. As Doctor Hitzrot said at a previous meeting of this society, cæcostomy is a "dirty" operation but the disease is likewise a "dirty" disease and cæcostomy in this regard does not compare unfavorably with ileostomy. Moreover, it has the advantage of not being a serious operation

but in the opinion of the speaker should be done more for adequate drainage than for irrigation alone. It is simple, closure is simple and not hazardous and if necessary can be repeated perfectly well.

DR. HAROLD NEUHOF stated that, for purposes of discussion, he would like to split off from the general group of ulcerative colitis a series of cases in which the patients were seriously sick with profound anemia, septic temperature, tenesmus and very frequent diarrhoeal stools mixed with blood and pus. The question is whether palliative measures, or even colostomy, sufficed for cases belonging in this group. These cases go on to death unless some measure of definitive relief is employed.

Doctor Neuhof referred to a series of six cases belonging to this group on which he had operated, having performed an ileostomy in all of them. In two, a colostomy had previously been done without relief. The first case was done approximately three years ago; the last about six months ago. The immediate result was striking in all the cases. As soon as the intestine was opened the temperature dropped to normal and remained so, even when it had run a septic course for weeks or months. The discharge of blood and pus from the rectum rapidly subsided. There was prompt improvement in the anemia.

The point that Doctor Neuhof wished to emphasize was the fact that none of these patients can as yet be reported as cured, although all but one have been greatly relieved. He wished to stress this point because an impression exists that one can, at a reasonably early time, close an ileostomy or cæcostomy opening. Doctor Santee has shown that in selected cases a cæcostomy can be closed at an early date. It must be remarked, however, that in some of these cases the disease pursues an intractable course and may be characterized by long periods of remissions, later to be followed by severe exacerbations.

Summarizing the results in his six cases, Doctor Neuhof notes that in one case there was recurrence of hemorrhages and purulent discharges several months after operation, followed by multiple involvement of joints and a progressive downhill course. The final result is not known about this patient; probably he has died.

All the other cases are alive. One did well for months after operation and since that time has had recurrent hemorrhages with a varying amount of pus in the stools. Occasional transfusions have kept this patient in reasonably good condition.

The third patient is the one shown here tonight in whom a result that may be termed excellent exists, but in whom some purulent discharge from the large bowel remains. A fourth patient, operated upon about a year and one-half ago, is doing very well with only occasional discharge of small amounts of pus. A fifth case, operated upon about a year ago, is doing fairly well, but has mild recurrences of discharge of blood and pus from the rectum from time to time. The last patient is still in the hospital now improving

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progressively, but having done so badly for a time that colectomy had been considered.

In short, rapid recovery from an alarmingly serious clinical picture is the rule after ileostomy. The brilliant immediate result, however, is not evidence that the patient will be cured in any other than a long period of time after the establishment of complete drainage of the small bowel.

ILEOSTOMY FOR ULCERATIVE COLITIS

DR. HAROLD NEUHOF presented a man, thirty-six years old, who came under observation a year ago with the following history:

Six years before, he began to have diarrhoea, with blood and pus in his bowel movements. Symptoms were at first mild, but became progressively more and more severe and incapacitating. The manifestations would be acute for a period of several weeks or a month and then there would be a relatively free interval in which there was little diarrhoea and a reduction in the amount of blood and pus in the stool. The remissions became shorter and less frequent. For six months before the time the patient came under observation, the manifestations became progressively worse. In all the acute phases of the disease, the patient has had some fever. For the last three months the fever had not only been persistent but gradually became septic in character. There was rapid loss of weight, pronounced weakness. Pain and tenesmus became agonizing and there was almost constant movements of small amounts of stool mixed with much blood and large quantities of pus. Various methods of treatment had been employed. The history of the patient indicates that they were thoroughly tried and that they included all the methods of non-operative treatment that have been advocated and that so-called specific vaccines have been employed. No method of treatment was discontinued until it was obvious to this intelligent patient that no result had been obtained. Upon two or three occasions, symptoms subsided with methods of treatment that had been employed, but the patient learned that such subsidences were the approach of a relatively free interval, rather than the effect of treatment.

On admission to the hospital the patient was profoundly anemic and asthenic. He had to be lifted on to the bed-pan for the almost incessant evacuation of blood, pus and diarrhoeal stool. A spiked temperature ranged from normal to 104; pulse was rapid and weak. The abdomen was scaphoid, with rigidly held abdominal musculature. It was generally tender throughout. Large doses of morphine were administered without much relief of tenesmus and with no effect on the diarrhoeal movements.

Operation, done a year ago under local anæsthesia, was preceded by a transfusion. A right-rectus muscle-splitting incision just below the umbilical level revealed a cæcum and ascending colon that were œdematous, infiltrated, with deep injection of the overlying serosa. A further exploration of the large gut was not made. The terminal ileum was drawn out of the wound and a site about five inches from the ileo-cæcal junction was chosen for the enterostomy. The mesentery of this loop was transfixed by a glass rod and then the loop was twisted ninety degrees. The two arms were sutured to the parietal peritoneum by fine catgut and the remainder of the short incision packed with iodoform gauze. A cage was placed over the wound.

After operation the patient's condition remained critical for several days, and there were severe cramps. The enterostomy loop was punctured with a Paquelin cautery on the second day. Temperature began dropping toward the normal and general condition began to improve on the third day. The

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glass rod was removed on the fifth day, the iodoform gauze pack on the sixth day. A week after operation the temperature was normal and has remained so ever since. With a dietary control, the enterostomy soon began to function adequately. At the present time there are usually two, sometimes three and four bowel movements from the enterostomy. There have been no bowel movements from the anus. The skin about the enterostomy has required considerable care in order to avoid irritation. There has been progressive diminution in the amount of blood and pus discharged from the rectum. In recent months blood has entirely disappeared and the amount of discharge of pus from the rectum is now from one-half to two ounces daily. There has been steady and progressive improvement in the condition of the patient. He has gained more than fifty pounds since the time of operation, is active physically, and suffers only from the necessity of caring for the enterostomy wound. From the time of convalescence from operation he has upon a number of occasions employed irrigations of the large bowel by way of a catheter that can be readily introduced through the enterostomy wound into the cæcum. These irrigations not only have proven of no value but they appeared to have tended to increase by irritation the amount of purulent discharge. Therefore, in recent months the patient has entirely discontinued irrigation of the large bowel.

The case is presented as one of intractable ulcerative colitis in which the disease has apparently been permanently arrested but not cured by long standing enterostomy. It is obvious that even after a year, closure of the enterostomy would not be justified.

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